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PRODUCT DATA REPRESENTATION AND EXCHANGE

Part: **Title:** Part 202 ARM EXPRESS

Purpose of this document as it relates to the target document is:

- ☒ Primary Content
☐ Issue Discussion
☐ Alternate Proposal
☐ Partial Content

Current Status: Complete

ABSTRACT:

A draft rendition of the Part 202 ARM in EXPRESS. The entities have been divided into groups.

KEYWORDS:

AP Interoperability,
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ARM module

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This document completes the author's action with respect to the definition of modules for constructing ARMs with the corresponding AIM data being defined. The remaining work is to complete the mapping and replace the DATA_TYPE domains with appropriate references.

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1 Introduction

This document specifies the information requirements for the exchange of associated draughting in terms of an EXPRESS representation of the ARM. It is based on the ARM requirements of ISO 10303, Part 202.

The information requirements are specified as a set modules and application objects. The information requirements are defined using the terminology of the subject area of this application protocol.

NOTES

1 – A graphical representation of the information requirements is given in figures accompanying the document.

2 – The information requirements correspond to those of the activities identified as being in the scope of this application protocol in annex F of ISO 10303, Part 202.

3 – The mapping table is specified in Clause 5.1 of Part 202 which shows how the information requirements are met using the integrated resources of this International Standard. The use of the integrated resources introduces additional requirements which are common to application protocols.

4 – The schema presented in this document is incomplete in the sense that many data types are specified in the EXPRESS representation as DATA_TYPE. It is intended that these data types will be expanded into the correct EXPRESS data types. This work will be done in terms of the mapping table specified in Clause 5.1 of Part 202.

2 Information Requirements

This clause presents the various Units of Functionality (UoFs). Note that they do not necessarily correspond to those in Part 202. The UoFs in this document were composed using tools which determine the connectivity of EXPRESS objects.

This schema was derived (more or less) automatically from the IS version of Part 202. The entities have been classified into eight groups: Product, Shape, Drawing Structure, Annotation, Draughting Annotation, Appearance, Appearance Elements, and Grouping. In some cases, a group has sub-groups. The overall schema is presented in Figure 1.

EXPRESS specification:

```
*)
SCHEMA associated_draughting_ARM;
(*
```

2.1 Product

The Product group contains product information, along with **Approval** and **Organization**. The entities of the Product group are shown in Figure 2.

:

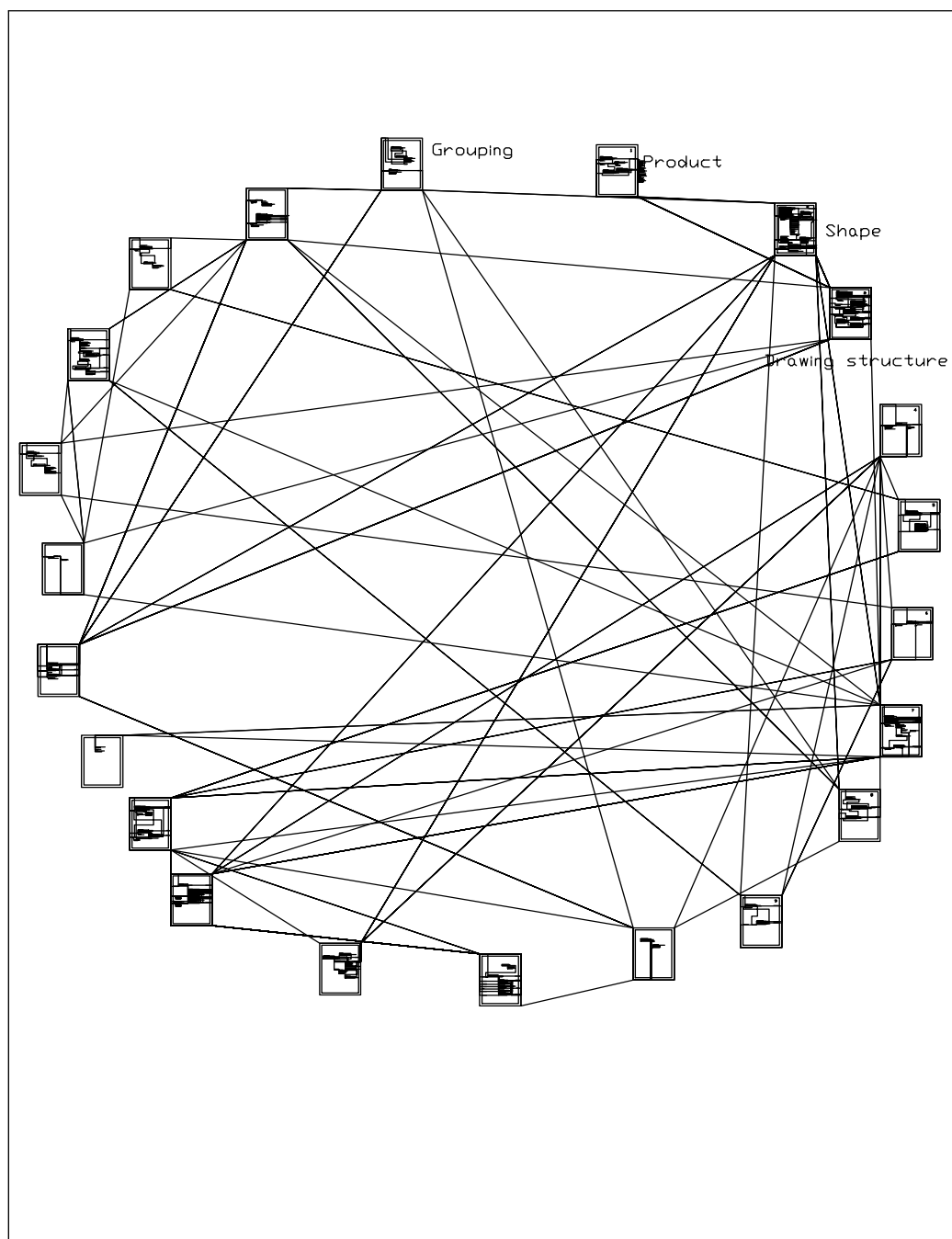


Figure 1 – Associated_draughting_ARM_schema

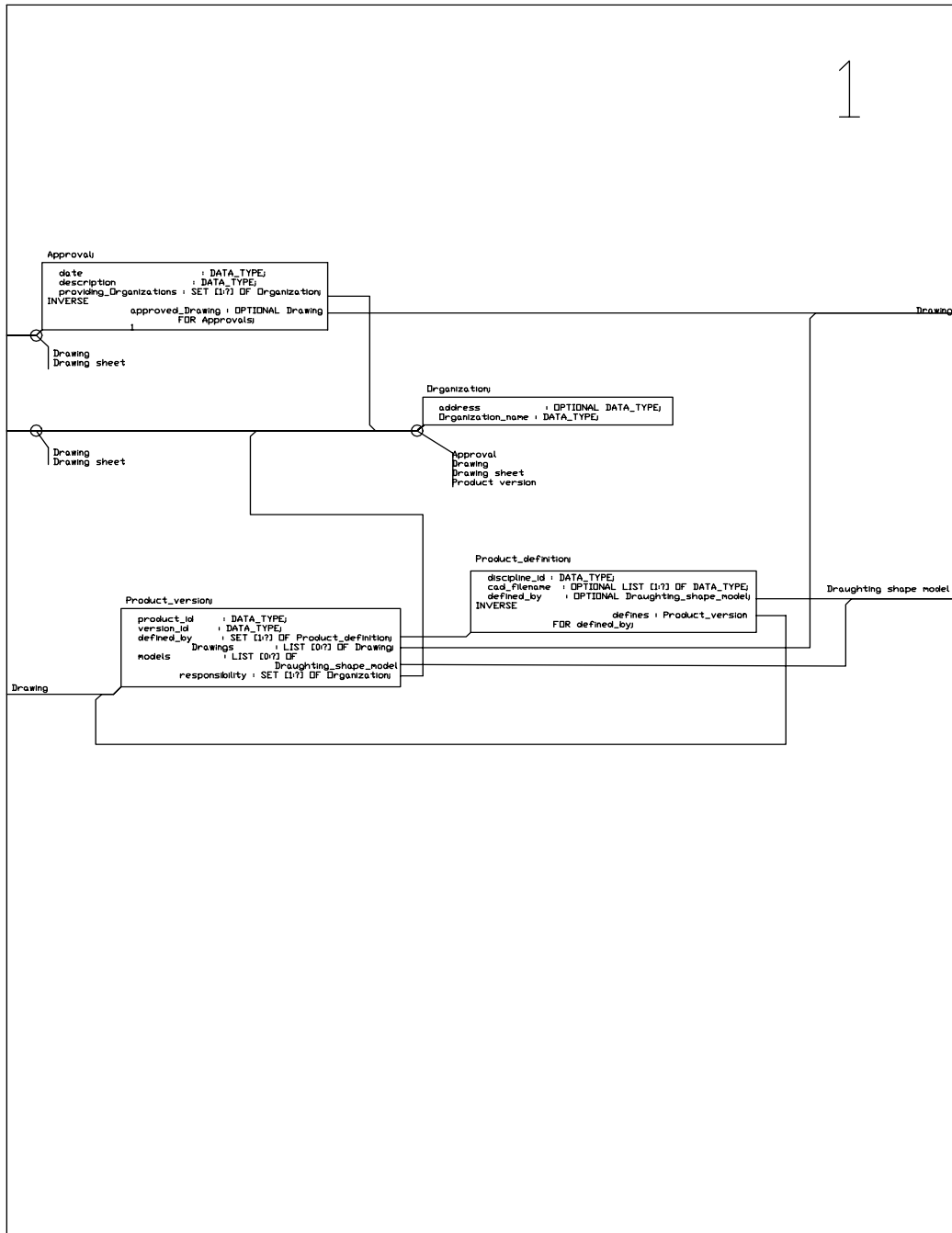


Figure 2 – Product

:

2.1.1 Approval

An **Approval** is information that indicates the **Drawing**, **Drawing_sheet**, or both have been reviewed for data content and for correctness of the presentation of that data.

EXPRESS specification:

```
*)
ENTITY Approval;
    date          : DATA_TYPE;
    description    : DATA_TYPE;
    providing_Organizations : SET [1:?] OF Organization;
INVERSE
    approved_Drawing : OPTIONAL Drawing
                      FOR Approvals;
END_ENTITY;
(*
```

Attribute definitions:

date: the date on which the **Approval** was assigned.

description: the organization-specific release status or the authorized modifications for the revision of the **Drawing**, **Drawing_sheet**, or both.

EXAMPLES

1 – A description could be “manufacturing release”, “see engineering change notice XXX for a description of the changes”, or “zone C-8, Dimension 8.00 was 8.25.”

providing_Organizations: The **Organizations** providing this **Approval**.

approved_Drawing: A possible **Drawing** governed by this **Approval**.

2.1.2 Organization

An **Organization** is a collection of persons or groups that designs, produces, and supplies products and services.

EXPRESS specification:

```
*)
ENTITY Organization;
    address        : OPTIONAL DATA_TYPE;
    organization_name : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

address: the postal delivery or geographical location of the **Organization**.

EXAMPLES

:

2 – An **Organization** could have a delivery address, a postal address, and an invoice address.

organization_name: the identification of a particular **Organization**.

2.1.3 Product_definition

A **Product_definition** is a characterization of a **Product_version** for a particular discipline.

EXPRESS specification:

```
*)
ENTITY Product_definition;
  discipline_id : DATA_TYPE;
  cad_filename  : OPTIONAL LIST [1:?] OF DATA_TYPE;
  defined_by    : OPTIONAL Draughting_shape_model;
INVERSE
  defines : Product_version
           FOR defined_by;
END_ENTITY;
(*
```

Attribute definitions:

discipline_id: the application to which the definition of the product pertains.

EXAMPLES

3 – The **discipline_id** could be engineering, manufacturing, quality assurance, or maintenance.

cad_filename: the name of the file that contains a **draughting shape model** or a portion of a **Draughting_shape_model** in a computer-aided design system.

defined_by: the **Draughting_shape_model** geometrically defining this **Product_definition**

EXAMPLES

4 – A **Draughting_shape_model** is not necessary in the exchange of textual drawings for a product.

defines: the **Product_version** which is defined by this **Product_definition**.

2.1.4 Product_version

A **Product_version** is a variant of a product that is, or is intended to be, produced or employed in a production or construction process.

EXPRESS specification:

```
*)
ENTITY Product_version;
  product_id : DATA_TYPE;
```

:

```
version_id      : DATA_TYPE;
defined_by     : SET [1:?] OF Product_definition;
drawings       : LIST [0:?] OF Drawing;
models         : LIST [0:?] OF Draughting_shape_model
responsibility : SET [1:?] OF Organization;
END_ENTITY;
(*)
```

Attribute definitions:

product_id: the identification of a product for a given **Organization**.

version_id: the identification of a variation of a product for a given **Organization**.

defined_by: the **Product_definition** object which defines this **Product_version**.

drawings: the set of **Drawing** objects which document this **Product_version**.

EXAMPLES

5 – Multi-detail drawings document more than one **Product_version**, tabulated drawings document more than one version of a product, and assembly drawings document the relationship between a **Product_version** and the multiple **Product_versions** which are its components.

6 – A wheel, that is not documented by a **Drawing**, may be represented as a sub-model in the geometric definition of a car that is documented by the **Drawing**.

models: the **Draughting_shape_model** which geometrically defines this **Product_version**.

EXAMPLES

7 – A **Draughting_shape_model** is not necessary in the exchange of textual drawings for a product.

responsibility the **Organizations** which have responsibility for this **Product_version**.

2.2 Shape

The Shape group contains entities pertaining to geometric shape. The Shape group is shown in Figure 3.

2.2.1 2d_cartesian_coordinate_space

A **2d_cartesian_coordinate_space** is a type of **Cartesian_coordinate_space** that is defined by two mutually perpendicular axes.

EXPRESS specification:

```
*)
ENTITY 2d_cartesian_coordinate_space
```


:

```
SUBTYPE OF (Cartesian_coordinate_space);
INVERSE
  subfigure_reference : OPTIONAL Annotation_subfigure_definition
                        FOR coordinate_space;
  sheet_reference     : OPTIONAL Drawing_sheet
                        FOR coordinate_space;
  view_reference      : OPTIONAL Drawing_view
                        FOR coordinate_space;
  user_symbol_reference : User_defined_symbol_definition
                        FOR coordinate_space;
END_ENTITY;
(*)
```

Attribute definitions:

subfigure_reference: The **Annotation_subfigure_definition** which has this **2d_cartesian_coordinate_space** as a coordinate space.

sheet_reference: The **Drawing_sheet** which has this **2d_cartesian_coordinate_space** as a coordinate space.

view_reference: The **Drawing_view** which has this **2d_cartesian_coordinate_space** as a coordinate space.

user_symbol_reference: The **User_defined_symbol_definition** which has this **2d_cartesian_coordinate_space** as a coordinate space.

2.2.2 2d_elementary_geometric_curve_set

A **2d_elementary_geometric_curve_set** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product by a wireframe model without topological information defined by elementary curves in a two- Dimensional coordinate system. This representation is formed by the use of points and elementary curves only. All curves are explicitly trimmed unless they are closed. Elementary curves include circles, composite curves, ellipses, lines, parabolas, hyperbolas, polylines, and trimmed curves.

NOTE – Elementary curves exclude b-spline curves, offset curves, curve replicas, surface curves, curves on surfaces, and curves defined within the parameter space of a surface.

EXPRESS specification:

```
*)
ENTITY 2d_elementary_geometric_curve_set
SUBTYPE OF Draughting_shape_model;
END_ENTITY;
(*)
```

2.2.3 2d_geometric_curve_set

A **2d_geometric_curve_set** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product by a wireframe model without topological

:

information defined in a 2-dimensional coordinate system. This representation is formed by the use of points and curves only. All curves are explicitly trimmed unless they are closed.

EXPRESS specification:

```
*)
ENTITY 2d_geometric_curve_set
SUBTYPE OF Draughting_shape_model;
END_ENTITY;
(*
```

2.2.4 2d_wireframe_with_topology

A **2d_wireframe_with_topology** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product by a wireframe model defined in a 2-dimensional coordinate system. This representation includes topology that consists of a graph of vertices and edges.

EXPRESS specification:

```
*)
ENTITY 2d_wireframe_with_topology
SUBTYPE OF (Draughting_shape_model);
END_ENTITY;
(*
```

2.2.5 3d_cartesian_coordinate_space

A **3d_cartesian_coordinate_space** is a type of **Cartesian_coordinate_space** that is defined by three mutually perpendicular axes.

EXPRESS specification:

```
*)
ENTITY 3d_cartesian_coordinate_space
SUBTYPE OF (Cartesian_coordinate_space);
    solid_angle_measure_unit : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

solid_angle_measure_unit: the increments used to define solid angular distances within a cartesian coordinate system.

EXAMPLES

8 – A **solid_angle_measure_unit** could be a steradian.

2.2.6 3d_non_topological_surface

A **3d_non_topological_surface** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product using surface geometry defined in a

:

3-dimensional coordinate system. This representation is formed by the use of points, curves, and surfaces. These shape models contain no topological information. All curves and surfaces are explicitly trimmed unless they are closed.

EXPRESS specification:

```
*)  
ENTITY 3d_non_topological_surface  
SUBTYPE OF (Draughting_shape_model);  
END_ENTITY;  
(*
```

2.2.7 3d_non_topological_wireframe

A **3d_non_topological_wireframe** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product using wireframe geometry defined in a 3-dimensional coordinate system. This representation is formed by the use of points and curves. These shape models contain no topological information. All curves are explicitly trimmed unless they are closed.

EXPRESS specification:

```
*)  
ENTITY 3d_non_topological_wireframe  
SUBTYPE OF (Draughting_shape_model);  
END_ENTITY;  
(*
```

2.2.8 3d_wireframe_with_topology

A **3d_wireframe_with_topology** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product by a wireframe model defined in a 3-dimensional coordinate system. This representation includes topology that consists of a graph of vertices and edges.

EXPRESS specification:

```
*)  
ENTITY 3d_wireframe_with_topology  
SUBTYPE OF (Draughting_shape_model);  
END_ENTITY;  
(*
```

2.2.9 Advanced_b_rep

An **Advanced_b_rep** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product by an advanced boundary representation solid model. The geometric shape of this model is represented using elementary surfaces, sculptured surfaces, swept surfaces, or a combination of these surfaces. This representation is defined by curves and surfaces and the topology that relates them. Boundaries are explicitly defined using topology.

:

EXPRESS specification:

```
*)  
ENTITY Advanced_b_rep  
SUBTYPE OF (Draughting_shape_model);  
END_ENTITY;  
(*
```

2.2.10 Cartesian_coordinate_space

A **Cartesian_coordinate_space** is a 2-dimensional or 3-dimensional space defined by a right-handed cartesian coordinate system with the same units on each axis. Each **Cartesian_coordinate_space** is either a **2d_cartesian_coordinate_space** or a **3d_cartesian_coordinate_space**.

EXPRESS specification:

```
*)  
ENTITY Cartesian_coordinate_space  
SUPERTYPE OF (ONEOF (2d_cartesian_coordinate_space,  
                      3d_cartesian_coordinate_space));  
length_measure_unit : DATA_TYPE;  
plane_angle_measure_unit : DATA_TYPE;  
END_ENTITY;  
(*
```

Attribute definitions:

length_measure_unit: the increments used to define linear distances or sizes within a **Cartesian_coordinate_space**.

plane_angle_measure_unit: the increments used to define angular distances within a **Cartesian_coordinate_space**.

2.2.11 Draughting_shape_model

A **Draughting_shape_model** is a representation of a product or portion of a product, used to create a **Drawing**. This representation consists of geometric elements defined in a coordinate space, and may also contain annotation placed in the same coordinate space, sub-models, or both.

EXPRESS specification:

```
*)  
ENTITY Draughting_shape_model  
SUPERTYPE OF (ONEOF  
(2d_elementary_geometric_curve_set,  
  2d_geometric_curve_set,  
  2d_wireframe_with_topology,  
  3d_non_topological_surface,  
  3d_non_topological_wireframe,  
  3d_wireframe_with_topology,  
  Advanced_b_rep,
```

:

```

        Elementary_B_rep,
        Faceted_B_rep,
        Manifold_surface_with_topology)
    ANDOR Sub_model_definition);
model_id      : DATA_TYPE;
coordinate_space : Cartesian_coordinate_space;
components    : LIST [0:?] OF Geometric_element;
model_annotation : LIST [0:?] OF Model_placed_annotation;
constituents   : LIST [0:?] OF Sub_model;
WHERE
    type_constraint: SIZEOF (TYPEOF (SELF) *
        ['ARM202.2d_NON_TOPOLOGICAL_WIREFRAME',
        'ARM202.2d_WIREFRAME_WITH_TOPOLOGY',
        'ARM202.3d_NON_TOPOLOGICAL_SURFACE',
        'ARM202.3d_NON_TOPOLOGICAL_WIREFRAME',
        'ARM202.3d_WIREFRAME_WITH_TOPOLOGY',
        'ARM202.ADVANCED_B_REP',
        'ARM202.ELEMENTARY_B_REP',
        'ARM202.FACETTED_B_REP',
        'ARM202.MANIFOLD_SURFACE_WITH_TOPOLOGY']) = 1;
END_ENTITY;
(*
```

Attribute definitions:

model_id: the identification of a particular draughting shape model.

coordinate_space: The **Cartesian_coordinate_space** which is the coordinate space of this **Draughting_shape_model**.

components: The **Geometric_elements** which belong to this **Draughting_shape_model**.

model_annotation: The set of **Model_placed_annotation** objects which are contained in this **Draughting_shape_model**.

constituents: The **Sub_model** objects which belong to this **Draughting_shape_model**.

Formal propositions:

type_constraint: The **Draughting_shape_model** shall be a SUPERTYPE of exactly one of **2d_non_topological_wireframe**, **2d_wireframe_with_topology**, **3d_non_topological_surface**, **3d_non_topological_wireframe**, **3d_wireframe_with_topology**, **Advanced_b_rep**, **Elementary_B_rep**, **Facetted_b_rep**, or **Manifold_surface_with_topology**.

2.2.12 Elementary_B_rep

An **Elementary_B_rep** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product by an elementary boundary representation solid model. The geometric shape of this model is represented using planes, cones, cylinders, spheres, and toroids. This representation is defined by curves and surfaces and the topology that relates them. Boundaries are explicitly defined by topology.

EXPRESS specification:

```
*)
ENTITY Elementary_B_rep
SUBTYPE OF (Draughting_shape_model);
END_ENTITY;
(*
```

2.2.13 Faceted_B_rep

A **Faceted_B_rep** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product by a faceted boundary representation solid model. The geometric shape of this model is represented using planar surfaces used as bounding surfaces. This representation is defined by points and planar polygons and the topology that relates them.

EXPRESS specification:

```
*)
ENTITY Facetted_b_rep
SUBTYPE OF (Draughting_shape_model);
END_ENTITY;
(*
```

2.2.14 Geometric_element

A **Geometric_element** is a specified type of individual geometry that is used in the representation of the shape of the product.

NOTE – Information in a **Draughting_callout** may be associated and visually directed to a geometric element by means of a **Projection_line**. The associativity of **Dimensions** is accomplished by means of a **Geometric_dimension**, not by the association of a **Projection_line** to a **Geometric_element**.

EXPRESS specification:

```
*)
ENTITY Geometric_element
SUPERTYPE OF (Group_geometric_element);
  Layers : LIST [1:?] OF Layer;
INVERSE
  parent_shape : Draughting_shape_model
                FOR components;
END_ENTITY;
(*
```

Attribute definitions:

Layers: the set of **Layer** objects which contain this **Geometric_element**.

parent_shape: the **Draughting_shape_model** of which this **Geometric_element** is a component.

:

2.2.15 Manifold_surface_with_topology

A **Manifold_surface_with_topology** is a type of **Draughting_shape_model** that represents the shape of a product or a portion of the shape of a product using manifold surfaces with topology. Topology and 3-dimensional curves and surfaces are used to define the boundary of the part.

EXPRESS specification:

```
*)  
ENTITY Manifold_surface_with_topology  
SUBTYPE OF (Draughting_shape_model);  
END_ENTITY;  
(*
```

2.2.16 Sub_model

A **Sub_model** is the presentation of a **Sub_model_definition** located within the coordinate system of a **Draughting_shape_model**.

EXPRESS specification:

```
*)  
ENTITY Sub_model;  
    transformation : DATA_TYPE;  
    definition      : Sub_model_definition;  
INVERSE  
parent : Draughting_shape_model  
    FOR constituents;  
END_ENTITY;  
(*
```

Attribute definitions:

transformation: the mathematical values that define the relationship between elements located in the coordinate system of the sub-model definition and their location in the coordinate system of the **Draughting_shape_model**.

definition: the **Sub_model_definition** which defines this **Sub_model**.

parent: the **Draughting_shape_model** to which this **Sub_model** belongs.

2.2.17 Sub_model_definition

A **Sub_model_definition** is a type of **Draughting_shape_model** that represents a constituent part of a product. The product is represented by a **Draughting_shape_model** of which one or more instances, or copies, of the **Sub_model_definition** are a part.

EXAMPLES

9 – Sub-model definitions may be created to check alignment and interference or to avoid creating large geometric models by referencing, not duplicating, the same combination of geometric and annotation elements.

:

EXPRESS specification:

```
*)
ENTITY Sub_model_definition
SUBTYPE OF (Draughting_shape_model);
INVERSE
    defines : LIST [1:?] OF Sub_model
            FOR definition;
END_ENTITY;
(*
```

Attribute definitions:

defines: the set of **Sub_model** objects for which this **Sub_model_definition** is the definition.

2.3 Drawing Structure

The Drawing Structure group contains entities describing those aspects of draughting which pertain to placing information on a 2-dimensional layout. The Drawing Structure group is shown in Figure 4.

2.3.1 Drawing

A **Drawing** is the presentation of product data in a human-interpretable form wherein the physical and functional requirements for that product are presented pictorially and textually.

EXPRESS specification:

```
*)
ENTITY Drawing;
    contract_reference      : OPTIONAL LIST [0:?] OF DATA_TYPE;
    drawing_number          : DATA_TYPE;
    drawing_version_id      : DATA_TYPE;
    drawing_specification   : OPTIONAL LIST [1:?] OF DATA_TYPE;
    drawing_type            : OPTIONAL DATA_TYPE;
    security_classification : OPTIONAL LIST [1:?] OF DATA_TYPE;
    title                   : OPTIONAL DATA_TYPE;
    approvals               : LIST [0:?] OF Approval;
    sheets                  : LIST [1:?] OF Drawing_sheet;
    responsibility           : Organization;
INVERSE
    documents: LIST [1:?] OF UNIQUE Product_version
            FOR Drawings;
END_ENTITY;
(*
```

Attribute definitions:

contract_reference: the identification of an agreement, between two or more parties, that defines activities related to the **Drawing**.

drawing_number: the identification of a particular **Drawing** by an organization.

drawing_version_id: the identification of a particular version of the **Drawing**.

:

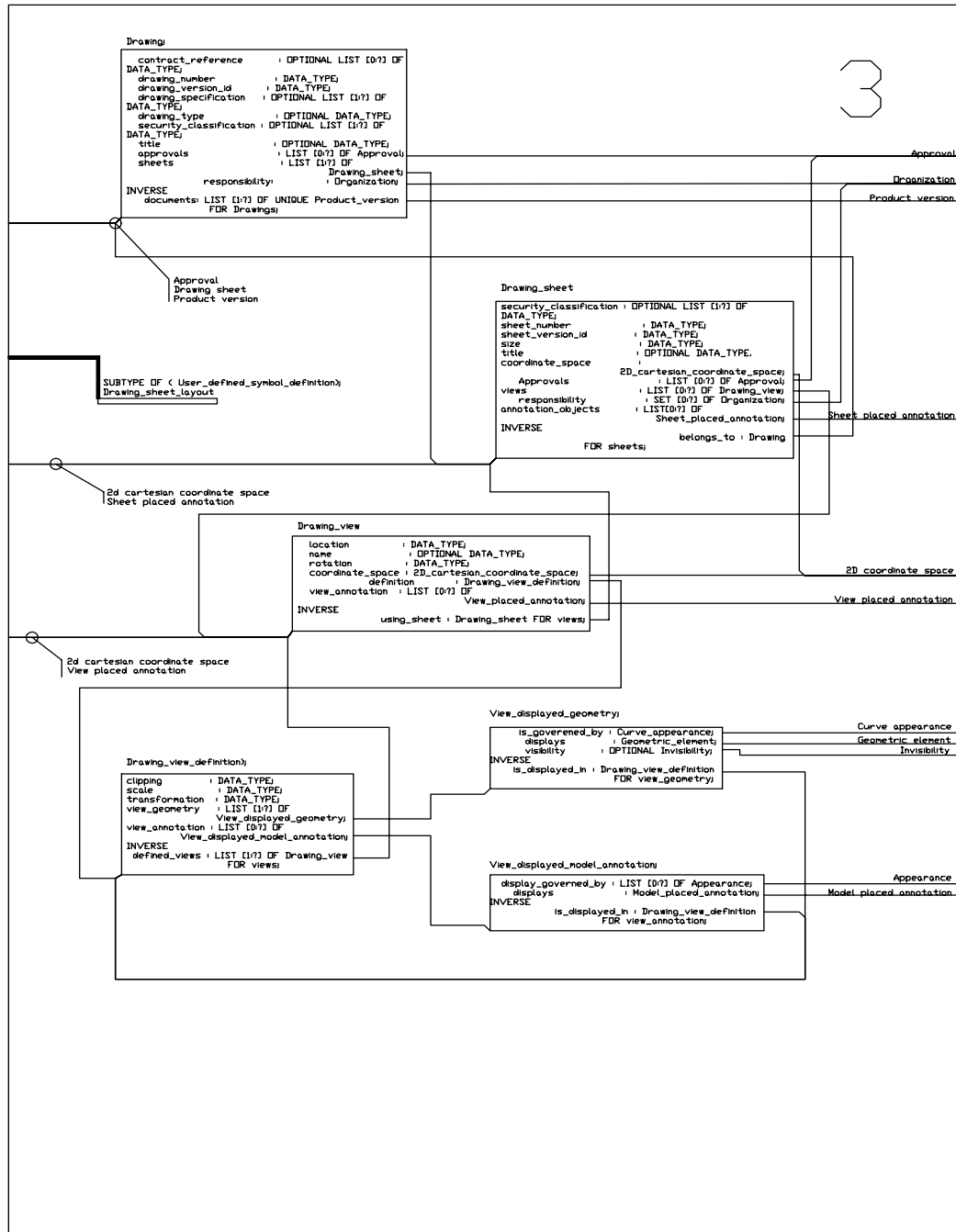


Figure 4 – Drawing Structure

:

drawing_specification: the identification of a standard to which the **Drawing** conforms. This standard specifies the presentation forms used in the **Drawing**.

drawing_type: the category of the **Drawing**. It may indicate the information content.

EXAMPLES

10 – A **drawing_type** could be an assembly drawing, a casting drawing, a piping diagram, an elevation drawing, or a land title drawing.

security_classification: the organization and external designation of the level of protection from unauthorized access to the **Drawing**.

title: a description of the content or subject matter of the **Drawing**.

approvals: the **Approval** objects which govern this **Drawing**.

sheets: the set of **Drawing_sheets** which belong to this **Drawing**.

responsibility: the **Organization** which has responsibility for this **Drawing**.

documents: the set of **Product_versions** which are documented by this **Drawing**. A **Drawing** may document more than one product, but the **Drawing** will only document one revision of each product.

2.3.2 Drawing_sheet

A **Drawing_sheet** is a logical division of a **Drawing** into a 2-dimensional area for the presentation of product data. A **Drawing_sheet** contains at least one **Drawing_view** or one **Draughting_annotation**.

EXPRESS specification:

```
*)
ENTITY Drawing_sheet
security_classification : OPTIONAL LIST [1:?] OF
DATA_TYPE;
sheet_number           : DATA_TYPE;
sheet_version_id       : DATA_TYPE;
size                   : DATA_TYPE;
title                  : OPTIONAL DATA_TYPE;
coordinate_space       : 2d_cartesian_coordinate_space;
approvals              : LIST [0:?] OF Approval;
views                  : LIST [0:?] OF Drawing_view;
responsibility         : SET [0:?] OF Organization;
annotation_objects     : LIST[0:?] OF Sheet_placed_annotation;
INVERSE
belongs_to : Drawing
            FOR sheets;
END_ENTITY;
```

:

(*

Attribute definitions:

security_classification: the organization and external designation of the level of protection from unauthorized access to the **Drawing_sheet**.

sheet_number: the page number for a particular **Drawing_sheet**.

sheet_version_id: the identification of a particular version of the **Drawing_sheet**.

NOTE – The **sheet_version_id** is typically taken from a sequential series.

size: the physical size of the presentation area of the **Drawing_sheet**. The physical size is defined by the length and width of the sheet in specified units of measure.

NOTE – The standard sheet size designator for a specified draughting standard, such as ANSI Y14.2 or ISO STD HDBK 12, can be derived from these values.

title: a description of the content or subject matter of the **Drawing_sheet**.

coordinate_space: the **2d_cartesian_coordinate_space** which acts as the coordinate space of this **Drawing_sheet**.

approvals: The set of **Approval** objects which govern this **Drawing_sheet**.

views: The set of **Drawing_views** which are contained in this **Drawing_sheet**.

NOTE – A **Drawing_sheet** may contain only annotation if views of the **Draughting_shape_model** are not defined or if the **Product_version** is not defined by a **Draughting_shape_model**.

responsibility: The **Organization** which has responsibility for this **Drawing_sheet**.

annotation_objects: The set of **Sheet_placed_annotation** objects which are contained in this **Drawing_sheet**.

NOTE – A **Drawing_sheet** may contain only views of the **Draughting_shape_model** which defines the **Product_version** and no additional annotation.

belongs_to: The **Drawing** to which this **Drawing_sheet** belongs.

2.3.3 Drawing_sheet_layout

A **Drawing_sheet_layout** is a type of **User_defined_symbol_definition** that specifies the layout, or format, of a sheet of a **Drawing**.

NOTE – The **Drawing_sheet_layout** may contain the title block, revision block, drawing zones, and microfilm alignment marks.

:

EXPRESS specification:

```
*)
ENTITY Drawing_sheet_layout
SUBTYPE OF ( User_defined_symbol_definition);
END_ENTITY;
(*
```

2.3.4 Drawing_view

A **Drawing_view** is a presentation on a **Drawing_sheet** of a 2-dimensional projection of a **Draughting_shape_model**, together with any annotation that refers to, or is relevant to, the view.

NOTE – The 2-dimensional projection is specified by a **Drawing_view_definition**.

EXPRESS specification:

```
*)
ENTITY Drawing_view
  location      : DATA_TYPE;
  name          : OPTIONAL DATA_TYPE;
  rotation      : DATA_TYPE;
  coordinate_space : 2d_cartesian_coordinate_space;
  definition     : Drawing_view_definition;
  view_annotation : LIST [0:?] OF View_placed_annotation;
INVERSE
  using_sheet : Drawing_sheet
              FOR views;
END_ENTITY;
(*
```

Attribute definitions:

location: the position of the origin of the coordinate system of the **Drawing_view** relative to the origin of the coordinate system of the **Drawing_sheet** where it is placed.

name: the identification of a particular **Drawing_view**.

rotation: the angle, measured counter-clockwise, between the x-axis of the coordinate system of the **Drawing_view** and the x-axis of the coordinate system of the **Drawing** sheet where it is placed.

coordinate_space: The **2d_cartesian_coordinate_space** entity which defines the coordinate space for the **Drawing_view**.

definition: the **Drawing_view_definition** entity which defines this **Drawing_view**.

view_annotation: The set of **View_placed_annotation** objects contained in this **Drawing-view**.

using_sheet: the **Drawing_sheet** which contains this **Drawing_view**.

:

NOTE – A **Drawing_sheet** may contain only annotation if views of the **Draughting_shape_model** are not defined or if the **Product_version** is not defined by a **Draughting_shape_model**.

2.3.5 Drawing_view_definition

A **Drawing_view_definition** is the set of instructions for producing a 2-dimensional planar projection of a draughting shape model from a specified position within its coordinate system. Additionally, clipping boundaries are specified to limit the content of the view, and a scale is specified to define the size of the presentation of the projected elements.

NOTE – The transformation for a **Draughting_shape_model** defined in 2-dimensional space includes only X and Y translation or rotation.

EXPRESS specification:

```
*)
ENTITY Drawing_view_definition;
clipping      : DATA_TYPE;
scale         : DATA_TYPE;
transformation : DATA_TYPE;
view_geometry : LIST [1:?] OF View_displayed_geometry;
view_annotation : LIST [0:?] OF View_displayed_model_annotation;
INVERSE
defined_views : LIST [1:?] OF Drawing_view
               FOR views;
END_ENTITY;
(*
```

Attribute definitions:

clipping: the geometric information necessary to define a 2-dimensional area or a 3-dimensional volume that encloses all viewable geometric and annotation elements of a **Draughting_shape_model**. Only those elements, or portions of any elements, that fall within this boundary will be displayed.

scale: the ratio between the size of the elements as defined in the **Draughting_shape_model** and the size of the elements as presented in the **Drawing_view**.

transformation: the mathematical values that define the relationship between elements located in the coordinate system of the **Draughting_shape_model** and their location in the coordinate system of the **Drawing** view.

view_geometry: the set of **View_displayed_geometry** objects which are displayed in this **Drawing_view_definition**.

view_annotation: the **View_displayed_model_annotation** objects which are displayed in this **Drawing_view_definition**.

defined_views: the set of **Drawing_view** entities which are defined by this **Drawing_view_definition**.

2.3.6 View_displayed_geometry

A **View_displayed_geometry** is the identification and assignment of appearance characteristics to a specific **Geometric_element** of the **Draughting_shape_model** when the element is presented in a **Drawing_view**.

NOTE – A geometric point in the **Draughting_shape_model** specifies a location without a physical definition that can be displayed in a **Drawing_view**. A **Point_marker_symbol** can be positioned in the **Draughting_shape_model** to represent the existence of the geometric point.

EXPRESS specification:

```
*)
ENTITY View_displayed_geometry;
  is_goverened_by : Curve_appearance;
  displays        : Geometric_element;
  visibility       : OPTIONAL Invisibility;
INVERSE
  is_displayed_in : Drawing_view_definition
                  FOR view_geometry;
END_ENTITY;
(*
```

Attribute definitions:

is_goverened_by: a **Curve_appearance** which governs the display of this **View_displayed_geometry**.

displays: the **Geometric_element** which is displayed as this **View_displayed_geometry**.

visibility: a possible **Invisibility** object which governs the display of this **View_displayed_geometry**.

is_displayed_in: the **Drawing_view_definition** in which this **View_displayed_geometry** is displayed.

2.3.7 View_displayed_model_annotation

A **View_displayed_model_annotation** is the identification and assignment of appearance characteristics to a **Model_placed_annotation** within the **Draughting_shape_model** when the annotation is presented in a **Drawing_view**.

NOTE – The appearance of an element for a specific visual presentation is governed by the last set of appearance characteristics assigned to it. Appearance characteristics assigned after the element has been defined with a set of appearance characteristics will override those which are part of the definition. Each new set of characteristics which are assigned will override those previously assigned. However, when an element is instanced or viewed through a viewing pipeline, the appearance characteristics assigned for that instance or view only apply to that instance or view and will not alter the original definition of that element.

EXPRESS specification:

```
*)
ENTITY View_displayed_model_annotation;
```

:

```
display_governed_by : LIST [0:?] OF Appearance;
displays             : Model_placed_annotation;
INVERSE
  is_displayed_in : Drawing_view_definition
                  FOR view_annotation;
END_ENTITY;
(*
```

Attribute definitions:

display_governed_by: the set of **Appearance** objects which govern the display of this **View_displayed_model_annotation**.

displays: the **Model_placed_annotation** which is displayed by this **View_displayed_model_annotation**.

is_displayed_in: the **Drawing_view_definition** which displays this **View_displayed_model_annotation**.

2.4 Annotation

The Annotation group contains those **Annotation_elements** which are general in nature, as opposed to those pertaining strictly to draughting.

2.4.1 Annotation_element

An **Annotation_element** is a type of **Draughting_annotation** that is the lowest-level discrete element that can either serve as annotation itself, or be used as a constituent of other annotation. The **Annotation_element** entity is shown in Figure 5.

EXPRESS specification:

```
*)
ENTITY Annotation_element
SUPERTYPE OF
(ONEOF (Annotation_curve,
        Annotation_subfigure,
        Annotation_symbol,
        Fill_area,
        Text)
SUBTYPE OF (Draughting_annotation);
INVERSE
composes : OPTIONAL User_defined_symbol_definition
          FOR composition;
END_ENTITY;
(*
```

```

graph TD
    Root[User_defined_symbol_definition] --> Subtype["SUBTYPE DF (Draughting_annotation)"]
    Root --> Annotation_element[Annotation_element]
    Annotation_element --> Inverse["INVERSE  
composes : OPTIONAL User_defined_symbol_definition  
FOR composition"]
    Inverse --> Optional["OPTIONAL User_defined_symbol_definition"]
    Inverse --> For_composition["FOR composition"]
    Optional --> One_of_optional["ONE OF"]
    One_of_optional --> Curve_distance_dimension[Curve distance dimension]
    One_of_optional --> Distance_dimension[Distance dimension]
    One_of_optional --> Geometric_dimension[Geometric dimension]
    One_of_optional --> Leader[Leader]
    One_of_optional --> Projection_line[Projection line]
    One_of_optional --> User_defined_symbol_definition[User_defined_symbol_definition]
    For_composition --> One_of_for["ONE OF"]
    One_of_for --> Annotation_curve[Annotation curve]
    One_of_for --> Annotation_subfigure[Annotation subfigure]
    One_of_for --> Annotation_symbol[Annotation symbol]
    One_of_for --> Fill_area[Fill area]
    One_of_for --> Text[text]
  
```

4

User_defined_symbol_definition

SUBTYPE DF (Draughting_annotation)

Annotation_element

INVERSE
composes : OPTIONAL User_defined_symbol_definition
FOR composition

OPTIONAL User_defined_symbol_definition

ONE OF

Curve distance dimension
Distance dimension
Geometric dimension
Leader
Projection line
User_defined_symbol_definition

Annotation curve
Annotation subfigure
Annotation symbol
Fill area
text

23

:

2.5 Text

2.5.1 Text

A **Text** is a type of **Annotation_element** that is a collection of characters which convey somehuman-interpretable information. Elements related to **Text** are show in Figure 6.

EXPRESS specification:

```
*)
ENTITY Text
SUBTYPE OF (Annotation_element);
  alignment      : DATA_TYPE;
  blanking_box   : OPTIONAL DATA_TYPE;
  displayed_box  : OPTIONAL DATA_TYPE;
  mirror_angle   : OPTIONAL DATA_TYPE;
  surrounding_box : OPTIONAL DATA_TYPE;
  appearance     : Text_appearance;
  composition    : LIST [1:?] OF Text_string;
INVERSE
  draughting_callout_composition : OPTIONAL Draughting_callout
                                FOR callout_text;
END_ENTITY;
(*
```

Attribute definitions:

alignment: a reference point on the text baseline, either left, right, or centre, that is used to align successive lines of text.

blanking_box: an area that the text occupies and is used to suppress the visual presentation of all other elements which are within this area.

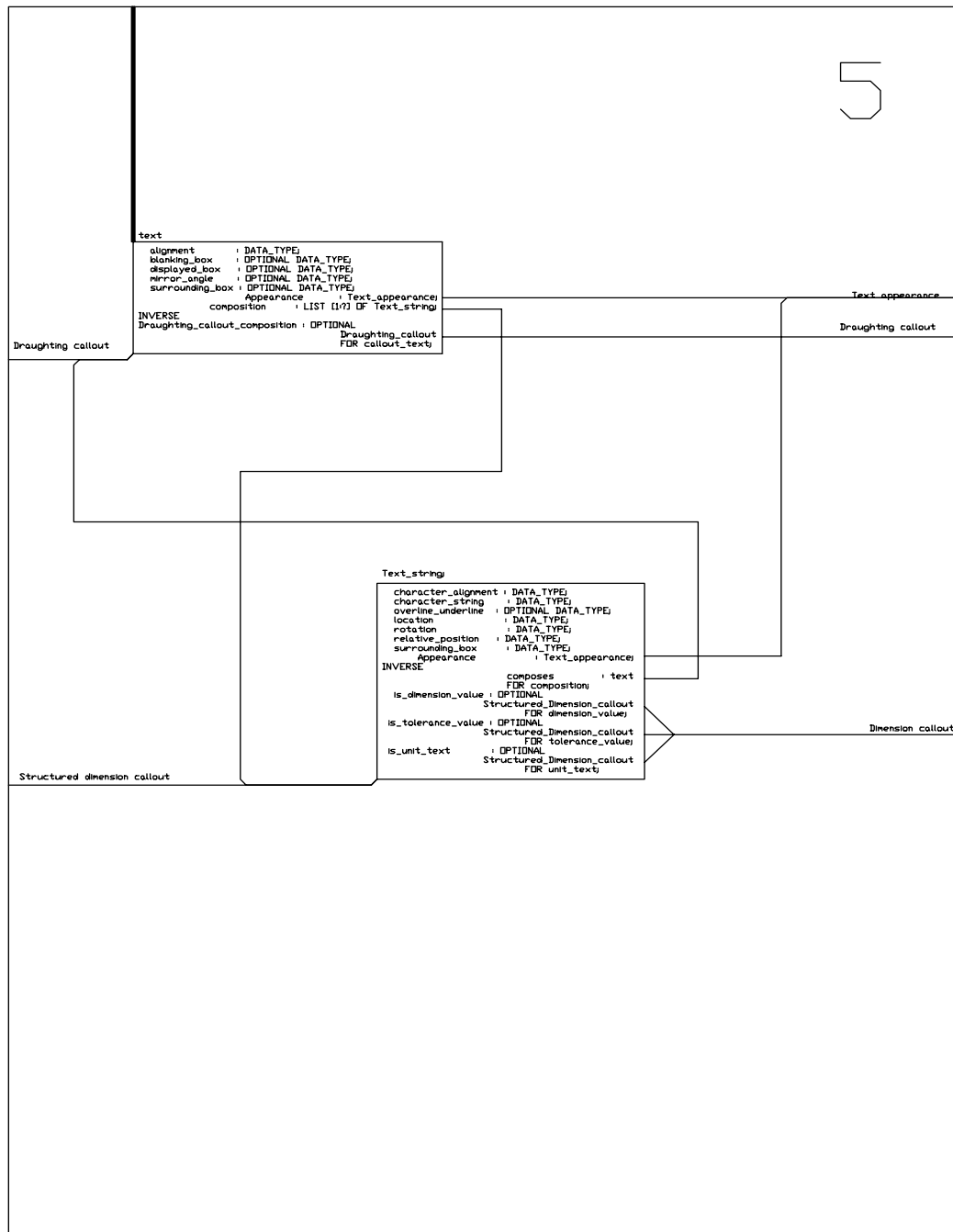
displayed_box: a rectangular box, composed of **Annotation_curves**, that encloses text where one side of the box is parallel to the text baseline.

mirror_angle: the angle, measured in a counter-clockwise direction from the text baseline, to an axis about which the text is mirrored. The mirror axis and text baseline intersect at the location of the text.

surrounding_box: the physical space that the text occupies and is defined by width, the distance of the left-most point of the left-most character to the right-most point of the right-most character measured parallel to the text baseline, and height, the distance of the lowest point of the lowest-reaching character to the highest point of the highest-reaching character measured perpendicular to the text baseline.

appearance: the default **Text_appearance** for this **Text**.

composition: the set of **Text_string** objects which compose this **Text**.



:

draughting_callout_composition: the **Draughting_callout** which is composed by this **Text** object.

2.5.2 Text_string

A **Text_string** is the smallest unit of text and is a collection of one or more characters that convey some human-interpretable information.

EXPRESS specification:

```
*)
ENTITY Text_string;
  character_alignment : DATA_TYPE;
  character_string    : DATA_TYPE;
  overline_underline : OPTIONAL DATA_TYPE;
  location            : DATA_TYPE;
  rotation            : DATA_TYPE;
  relative_position   : DATA_TYPE;
  surrounding_box      : DATA_TYPE;
  appearance          : Text_appearance;
INVERSE
  composes            : Text
                      FOR composition;
  is_dimension_value  : OPTIONAL Structured_dimension_callout
                      FOR dimension_value;
  is_tolerance_value  : OPTIONAL Structured_dimension_callout
                      FOR tolerance_value;
  is_unit_text        : OPTIONAL Structured_dimension_callout
                      FOR unit_text;
END_ENTITY;
(*
```

Attribute definitions:

character_alignment: the relative position of successive characters in a string of text. The **character_alignment** is either left, right, up, or down.

character_string: the list of characters that compose the string of text.

overline_underline: the specification that there is a line placed either over or under the **Text_string**. The **overline_underline** need not be specified for a particular **Text_string**.

location: the position of the **Text_string** in the placement coordinate system.

rotation: the angle, measured counter-clockwise, between the baseline of the text and the x-axis of the coordinate system into which it is being placed.

relative_position: the location of the **Text_string** with respect to the location of the **Text** of which it is a component.

surrounding_box: the physical space that the **Text_string** occupies and is defined by width, the distance of the left-most point of the left-most character to the right-most point of the right-

:

most character measured parallel to the text baseline, and height, the distance of the lowest point of the lowest-reaching character to the highest point of the highest-reaching character measured perpendicular to the text baseline.

appearance: the **Text_appearance** object which applies to this **Text_string**.

composes: the **Text** object of which this **Text_string** is a component.

is_dimension_value: the **Structured_dimension_callout** for which this **Text_string** provides a dimension value.

is_tolerance_value: the **Structured_dimension_callout** for which this **Text_string** provides a tolerance value.

is_unit_text: the **Structured_dimension_callout** for which this **Text_string** provides a unit text.

2.6 Annotation Curve

2.6.1 Annotation_curve

An **Annotation_curve** is a type of **Annotation_element** that is a 2-dimensional trimmed curve used only to annotate a **Drawing** or a **Draughting_shape_model** and which is defined in the coordinate system in which it is used. An **Annotation_curve** does not define the shape of the product. Each **Annotation_curve** may be a **Directed_curve**. The **Annotation_curve** entity is shown in Figure 7.

EXPRESS specification:

```
*)
ENTITY Annotation_curve
SUPERTYPE OF (Directed_curve)
SUBTYPE OF (Annotation_element);
    appearance : Curve_appearance;
INVERSE
composes : OPTIONAL Draughting_callout
            FOR composition;
defines   : OPTIONAL Fill_area_boundary
            FOR definition;
END_ENTITY;
(*
```

Attribute definitions:

appearance: The **Curve_appearance** which applies to this **Annotation_curve**.

2.7 Annotation Symbol

Entities relate to **Annotation_symbol** are show in Figure 8.

:

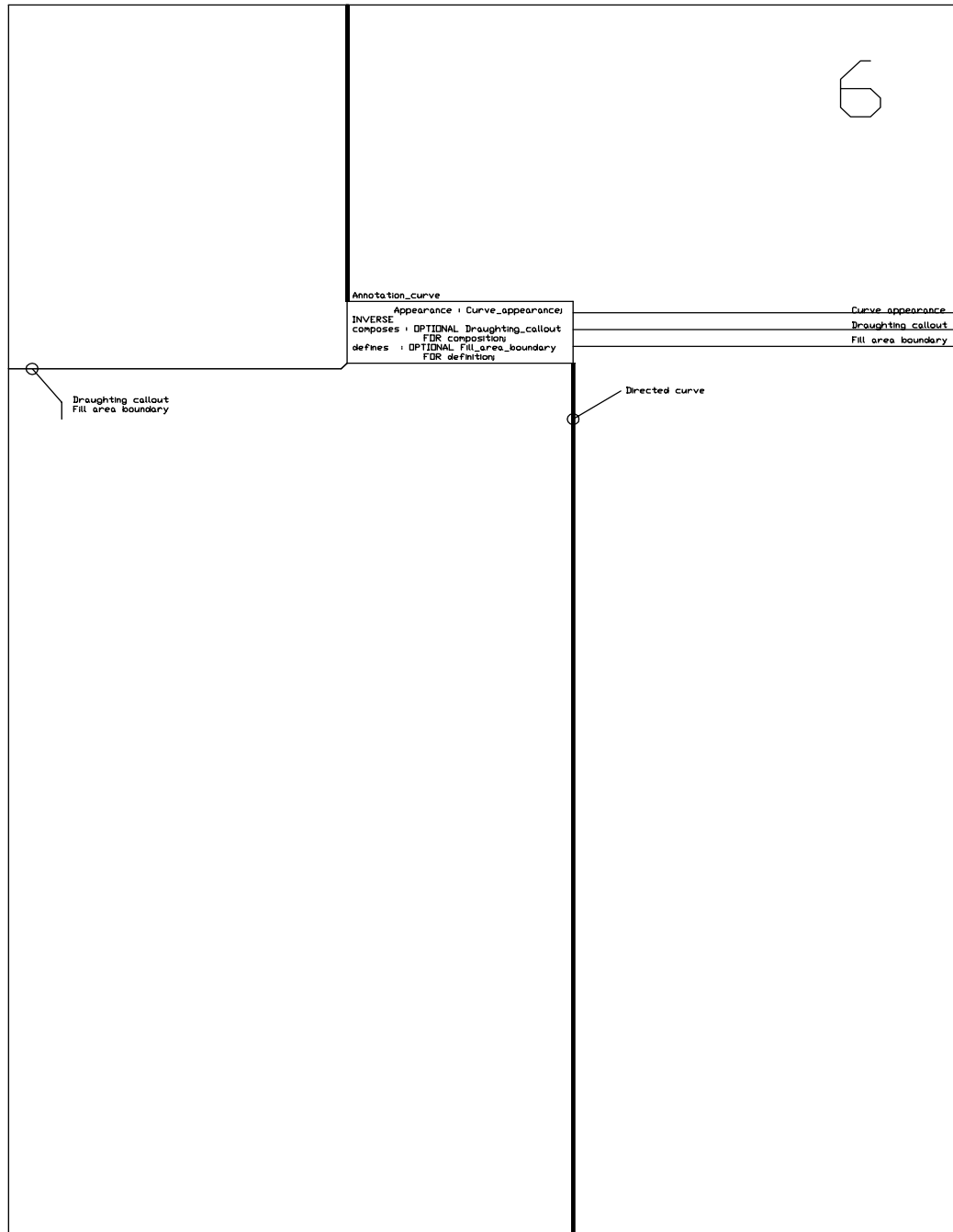


Figure 7 – Annotation curve

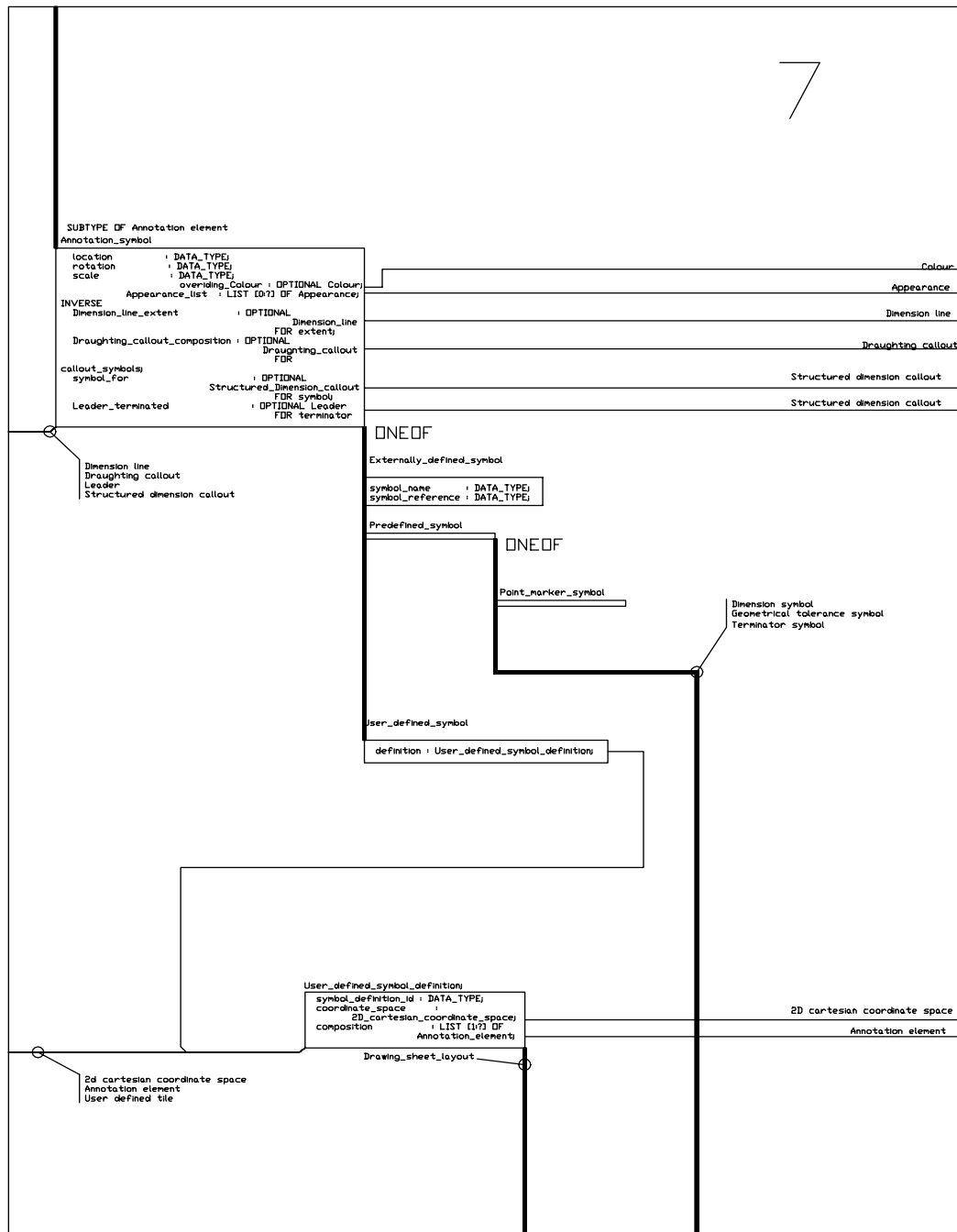


Figure 8 – Annotation Symbol

:

2.7.1 Annotation_symbol

An **Annotation_symbol** is a type of **Annotation_element** that is the presentation of a symbol definition that is either externally defined, predefined, or defined explicitly as a combination of annotation elements. The **Annotation_symbol** is located within the coordinate system of a **Drawing_sheet**, **Drawing_view**, **Draughting_shape_model**, or another symbol.

EXPRESS specification:

```
*)
ENTITY Annotation_symbol
SUPERTYPE OF (ONEOF (Externally_defined_symbol,
                     Predefined_symbol,
                     User_defined_symbol))
SUBTYPE OF (Annotation_element);
  location          : DATA_TYPE;
  rotation          : DATA_TYPE;
  scale             : DATA_TYPE;
  overriding_Colour : OPTIONAL Colour;
  appearance_list  : LIST [0:?] OF Appearance;
INVERSE
  Dimension_line_extent      : OPTIONAL Dimension_line
                              FOR extent;
  Draughting_callout_composition : OPTIONAL Draughting_callout
                              FOR callout_symbols;
  symbol_for                 : OPTIONAL Structured_dimension_callout
                              FOR symbol;
  Leader_terminated          : OPTIONAL Leader
                              FOR terminator
END_ENTITY;
(*
```

Attribute definitions:

location: the position of the origin of the coordinate system within which the symbol definition exists relative to the origin of the coordinate system into which the symbol is being placed.

rotation: the angle, measured counter-clockwise, between the x-axis of the coordinate system within which the symbol definition exists and the x-axis of the coordinate system into which the symbol is being placed.

scale: the ratio between the size of the symbol as defined and the size of the symbol as presented. The scale in the x-coordinate need not equal the scale in the y-coordinate.

overriding_Colour: the overriding **Colour** for this **Annotation_symbol**.

appearance_list: The set of **Appearances** applying to this **Annotation_symbol**.

symbol_for: the **Structured_Dimension_callout** which has as a symbol this **Annotation-symbol**.

:

Dimension_line_extent: the **Dimension_line** whose extent is indicated by this **Annotation_symbol**.

Draughting_callout_composition: the **Draughting_callout** which is composed of by this **Annotation_symbol**.

symbol_for: the **Structured_Dimension_callout** which has this **Annotation_symbol** as a symbol.

Leader_terminated: The **Leader** terminated by this **Annotation_symbol**.

2.7.2 Externally_defined_symbol

An **Externally_defined_symbol** is a type of **Annotation_symbol** in which the definition of the symbol is found in a known source. This known source is agreed to by all parties involved in the exchange of the **Drawings** on which the symbol appears. The definition of the symbol shall include the specification of the origin of the symbol and all constituent components of the symbol, their size, appearance, and relative location.

NOTE – The appearance of the symbol components may include curve width, line font, text font, and colour.

EXPRESS specification:

```
*)
ENTITY Externally_defined_symbol
SUBTYPE OF (Annotation_symbol);
    symbol_name      : DATA_TYPE;
    symbol_reference : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

symbol_name: the identification of a particular symbol within the known source.

symbol_reference: the known source that contains a set of symbols from which the symbol is selected.

2.7.3 Point_marker_symbol

A **Point_marker_symbol** is a type of **Predefined_symbol** that is used to visually present the location of a point in a **Draughting_shape_model**, **Drawing_sheet**, **Drawing_view**, or another symbol.

EXPRESS specification:

```
*)
ENTITY Point_marker_symbol
SUBTYPE OF (Predefined_symbol);
END_ENTITY;
(*
```

:

2.7.4 Predefined_symbol

A **Predefined_symbol** is a type of **Annotation_symbol** in which the definition of the symbol is explicitly defined in ISO 10303.

EXPRESS specification:

```
*)
ENTITY Predefined_symbol
SUPERTYPE OF (ONEOF (Dimension_symbol,
                     Geometrical_tolerance_symbol,
                     Point_marker_symbol,
                     Terminator_symbol))
SUBTYPE OF (Annotation_symbol);
END_ENTITY;
(*
```

2.7.5 User_defined_symbol

A **User_defined_symbol** is a type of **Annotation_symbol** in which the definition of the symbol is an explicit collection of **Annotation_elements**.

EXPRESS specification:

```
*)
ENTITY User_defined_symbol
SUBTYPE OF (Annotation_symbol);
    definition : User_defined_symbol_definition;
END_ENTITY;
(*
```

Attribute definitions:

definition: the **User_defined_symbol_definition** object which defines this **User_defined_symbol**.

2.7.6 User_defined_symbol_definition

A **User_defined_symbol_definition** is a collection of defined **Annotation_elements**, along with their placements, in a definitional coordinate space that represent a distinct concept.

EXPRESS specification:

```
*)
ENTITY User_defined_symbol_definition;
    symbol_definition_id : DATA_TYPE;
    coordinate_space      : 2d_cartesian_coordinate_space;
    composition           : LIST [1:?] OF Annotation_element;
END_ENTITY;
(*
```

Attribute definitions:

symbol_definition_id: the identification of a particular symbol.

:

coordinate_space: the **2dcartesian_coordinate_space** which defines the coordinate space for this **User_defined_symbol_definition**.

composition: the set of **Annotation_element** objects which compose the definition of this **User_defined_symbol_definition**.

2.8 Annotation Subfigure

Entities related to Annotation Subfigure are shown in Figure 9.

2.8.1 Annotation_subfigure

An **Annotation_subfigure** is a type of **Annotation_element** that is the presentation of an **Annotation_subfigure_definition** located within the coordinate system of a **Drawing_sheet**, a **Drawing_view**, a **Draughting_shape_model**, or another subfigure.

EXPRESS specification:

```
*)  
ENTITY Annotation_subfigure  
SUBTYPE OF (Annotation_element);  
    location    : DATA_TYPE;  
    rotation    : DATA_TYPE;  
    scale       : DATA_TYPE;  
    definition  : Annotation_subfigure_definition;  
END_ENTITY;  
(*
```

Attribute definitions:

location: the position of the origin of the coordinate system in which the subfigure is defined relative to the origin of the coordinate system into which the subfigure is being placed.

rotation: the angle, measured counter-clockwise, between the x-axis of the coordinate system in which the subfigure is defined and the x-axis of the coordinate system into which the subfigure is being placed.

scale: the ratio between the size of the subfigure as defined and the size of the subfigure as presented. The scale in the x-coordinate need not equal the scale in the y-coordinate.

definition: The **Annotation_subfigure_definition** which defines this **Annotation_subfigure**.

2.8.2 Annotation_subfigure_definition

An **Annotation_subfigure_definition** is a collection of defined **Annotation_elements**, along with their placements, in a definitional coordinate space.

EXPRESS specification:

:

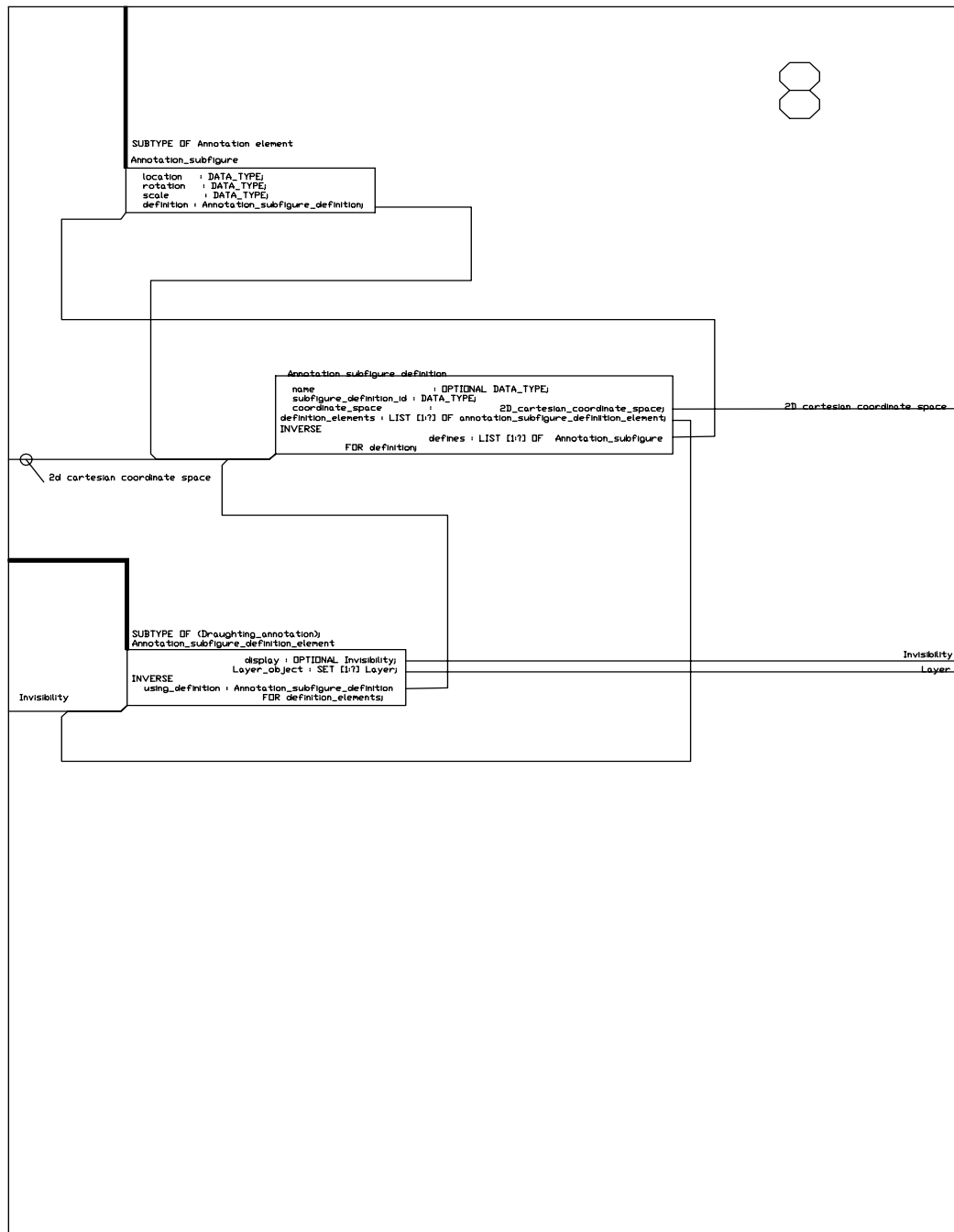


Figure 9 – Annotation Subfigure

:

```
*)
ENTITY Annotation_subfigure_definition;
  name : OPTIONAL DATA_TYPE;
  subfigure_definition_id : DATA_TYPE;
  coordinate_space : 2d_cartesian_coordinate_space;
  definition_elements : LIST [1:?] OF
    annotation_subfigure_definition_element;
INVERSE
defines : LIST [1:?] OF Annotation_subfigure
  FOR definition;
END_ENTITY;
(*
```

Attribute definitions:

name: the identification of a particular subfigure definition.

subfigure_definition_id: the identification of this particular **Annotation_subfigure_definition**.

coordinate_space: the coordinate space for this **Annotation_subfigure_definition**.

definition_elements: The set of **Annotation_subfigure_definition_elements** which compose this **Annotation_subfigure_definition**.

defines: the set of **Annotation_subfigure** objects for which this **Annotation_subfigure_definition** is the definition.

2.8.3 Annotation_subfigure_definition_element

An **Annotation_subfigure_definition_element** is annotation that is used as a constituent of an **Annotation_subfigure_definition**.

EXPRESS specification:

```
*)
ENTITY Annotation_subfigure_definition_element
SUBTYPE OF (Draughting_annotation);
  display : OPTIONAL Invisibility;
  layer_object : SET [1:?] Layer;
INVERSE
  using_definition : Annotation_subfigure_definition
    FOR definition_elements;
END_ENTITY;
(*
```

Attribute definitions:

display: the **Invisibility** object which may govern the display of this **Annotation_subfigure_definition_element**.

using_definition: the **Annotation_subfigure_definition** of which this **Annotation_subfigure_definition_element** is a component.

:

layer_object: the **Layers** containing this **Annotation_subfigure_definition_element**.

2.9 Fill Area

Entities related to Fill Area are shown in Figure 10.

2.9.1 Fill_area

A **Fill_area** is a type of **Annotation_element** that is a bounded area containing colouring, hatching, or tiling that indicate its extent and content. A **Fill_area** communicates some aspect of a physical part characteristic, distinguishes some aspect of a physical part from its surroundings, is part of another piece of annotation, or is used as annotation by itself.

NOTES

1 – **Fill_areas** are derived from **Geometric_elements**, **Annotation_curves**, or a combination of both. The two types of curves can be combined if the **Geometric_elements** do not result in a closed boundary necessary for the confinement of the filled area. Only those **Annotation_curves** used for geometric construction are included in the boundary of a **Fill_area**.

2 – One **Fill_area** can be defined coincident with another **Fill_area**, each having separate **Fill_area_appearances**. Among the set of coincidental **Fill_areas**, if there is no **Fill_area** defined with a **Solid_Fill_area** identified as the background colour, the default background colour is transparent.

EXPRESS specification:

```
*)  
ENTITY Fill_area  
SUBTYPE OF (Annotation_element );  
    reference_point : OPTIONAL DATA_TYPE;  
    fill_appearance : Fill_area_appearance;  
    boundary        : LIST [1:?] OF Fill_area_boundary;  
END_ENTITY;  
(*
```

Attribute definitions:

reference_point: a point within the **Fill_area** used in the placement and initiation of the **Fill_area_appearance**. The **reference_point** establishes a point through which a line of a **Hatching_pattern** passes or at which the origin of a **Tile** is located. The **reference_point** also establishes the point at which the first visible segment of a **Line_font** used as the **Curve_appearance** for a **Hatching_pattern** starts.

fill_Appearance: the **Fill_area_appearance** which applies to this **Fill_area**.

boundary: the set of **Fill_area_boundary** objects which bound this **Fill_area**.

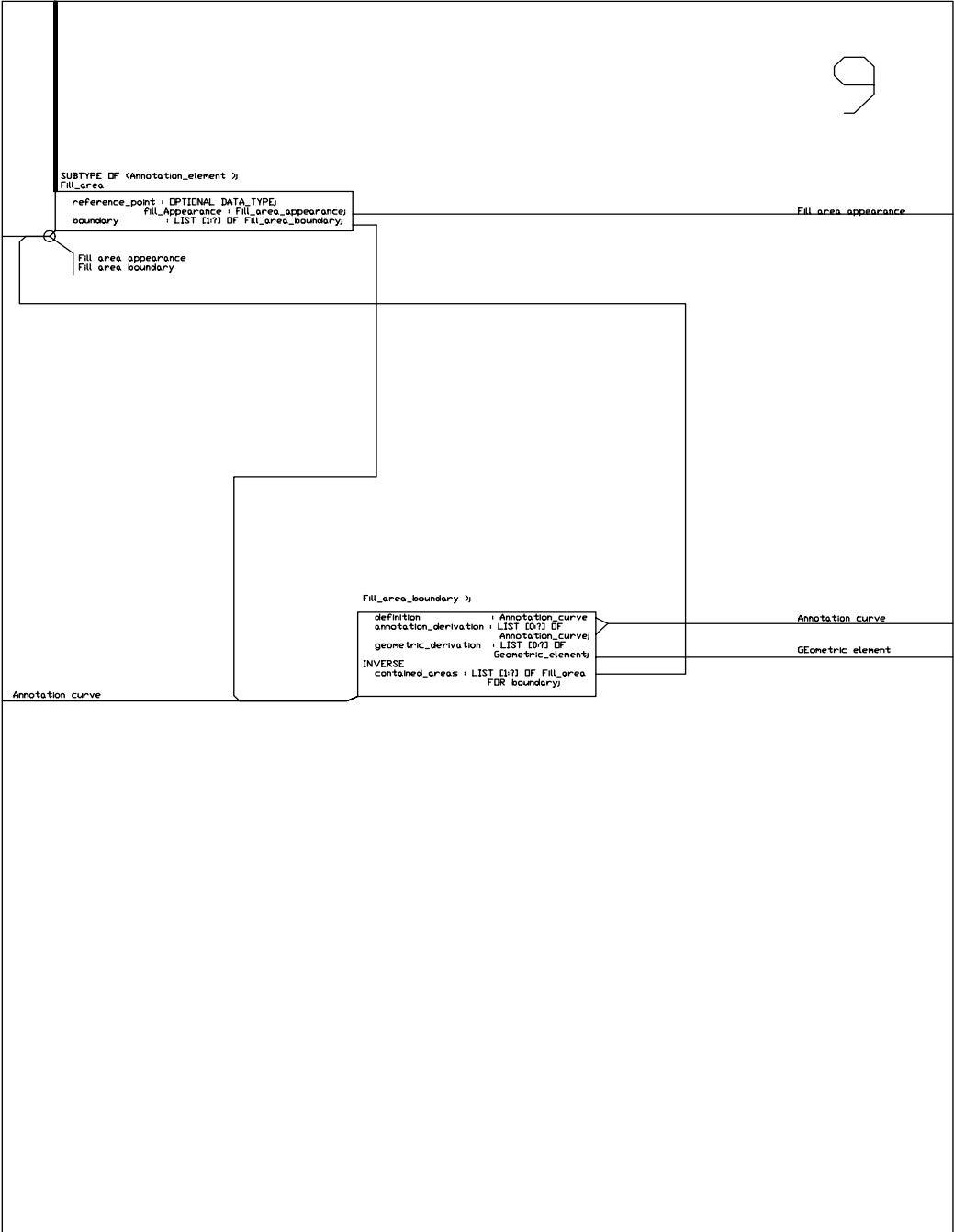


Figure 10 – Fill Area

:

2.9.2 Fill_area_boundary

A **Fill_area_boundary** is an **Annotation_curve** in the same coordinate space that defines the limits of a **Fill_area**. The curve is closed and not self-intersecting. In a 3-dimensional fill area, the curve either forms a closed curve on a planar surface or is coincident with the boundary of a closed surface.

NOTE – The curves composing the **Fill_area_boundary** are derived from, and coincident with, the geometric curves or surfaces and the **Annotation_curves** that define the extent of the **Fill_area**.

EXPRESS specification:

```
*)
ENTITY Fill_area_boundary;
  definition          : Annotation_curve
  annotation_derivation : LIST [0:?] OF Annotation_curve;
  geometric_derivation  : LIST [0:?] OF Geometric_element;
INVERSE
  contained_areas : LIST [1:?] OF Fill_area
                  FOR boundary;
END_ENTITY;
(*
```

Attribute definitions:

definition: the **Annotation_curve** which defines this **Fill_area_boundary**.

annotation_derivation: the set of **Annotation_curve** objects which form the basis for this **Fill_area_boundary**.

geometric_derivation: the set of **Geometric_element** objects which form the basis for this **Fill_area_boundary**.

contained_areas: the set of **Fill_area** objects which are contained within this **Fill_area_boundary**.

2.10 Draughting Annotation

The Draughting Annotation group contains those annotation entities which pertain to the draughting application, as opposed to those which are general in nature.

2.10.1 Draughting_annotation

A **Draughting_annotation** is text and symbology applied to either a **Drawing_sheet**, **Drawing_view**, another piece of annotation, or a **Draughting_shape_model**, for the purpose of communicating product data and drawing interpretation information. The **Draughting_annotation** entity is shown in Figure 11.

EXPRESS specification:

```
*)
ENTITY Draughting_annotation
```

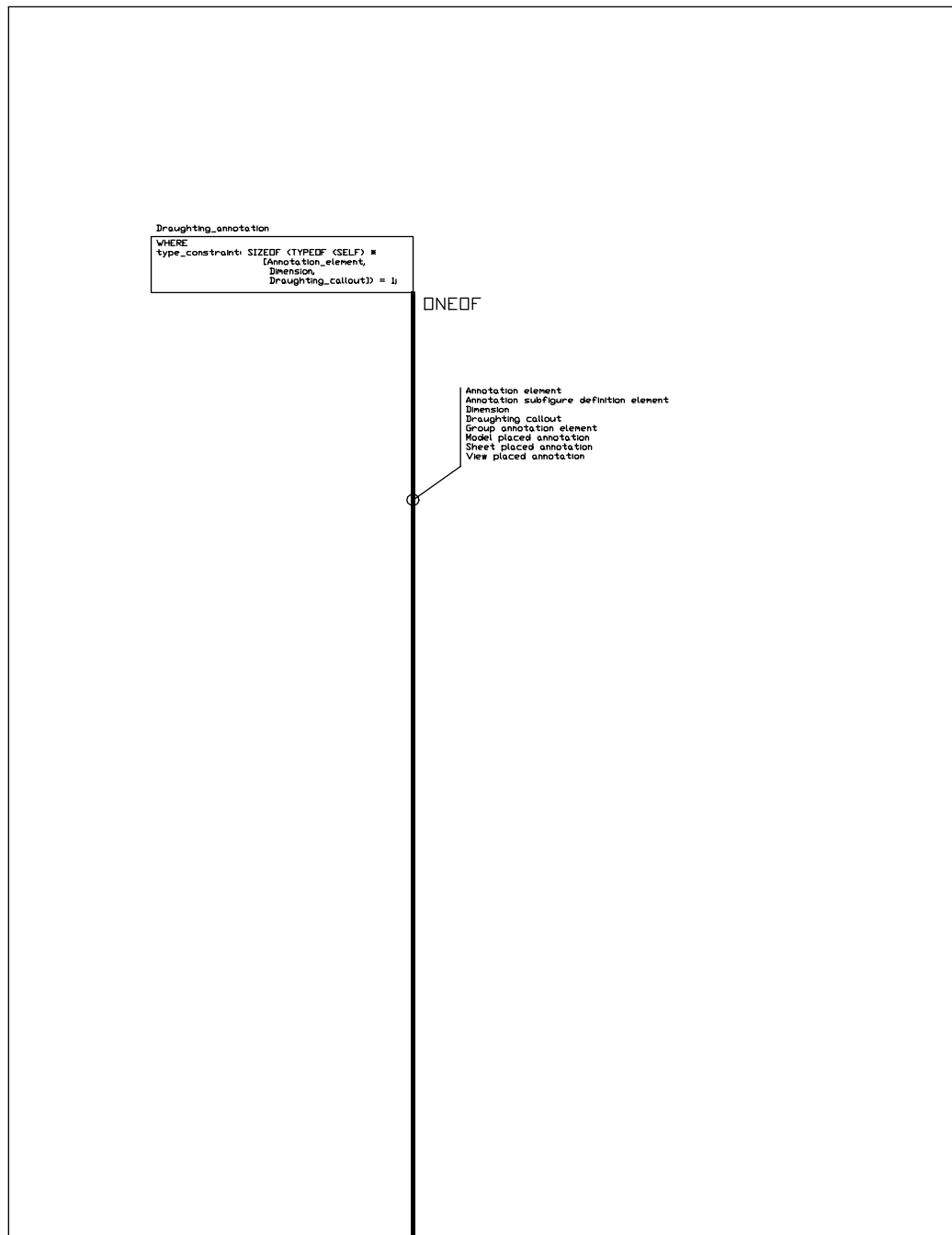


Figure 11 – Draughting Annotation

:

```
SUPERTYPE OF ( Group_annotation_element
    ANDOR Annotation_subfigure_definition_element
    AND(ONEOF (Annotation_element,
        Dimension,
        Draughting_callout)
    ANDOR ONEOF (Model_placed_annotation,
        Sheet_placed_annotation,
        View_placed_annotation)));
WHERE
type_constraint: SIZEOF (TYPEOF (SELF) *
    [Annotation_element,
    Dimension,
    Draughting_callout]) = 1;
END_ENTITY;
(*
```

Formal propositions:

type_constraint: A **Draughting_annotation** shall be the supertype of exactly one of **Annotation_element**, **Dimension**, or **Draughting_callout**.

2.11 Conventional Dimensions

The Conventional Dimensions sub-group contains those dimension entities which do not associate with model geometry. Entities related to Conventional Dimensions are shown in Figure 12.

2.11.1 Dimension

A **Dimension** is a type of **Draughting_annotation** that is the graphical presentation of the dimension value, associated information, and the necessary symbology to accurately depict its area of application.

EXPRESS specification:

```
*)
ENTITY Dimension
SUPERTYPE OF ( ONEOF(Angular_dimension,
    Curve_dimension,
    Diameter_dimension,
    Leader_directed_dimension,
    Linear_dimension,
    Ordinate_Dimension,
    Radius_dimension))
SUBTYPE OF (Draughting_annotation);
    primary_callout : Dimension_callout;
    secondary_callout : OPTIONAL Dimension_callout;
END_ENTITY;
(*
```

Attribute definitions:

primary_callout: The **Dimension_callout** which is the primary callout for this **Dimension**.

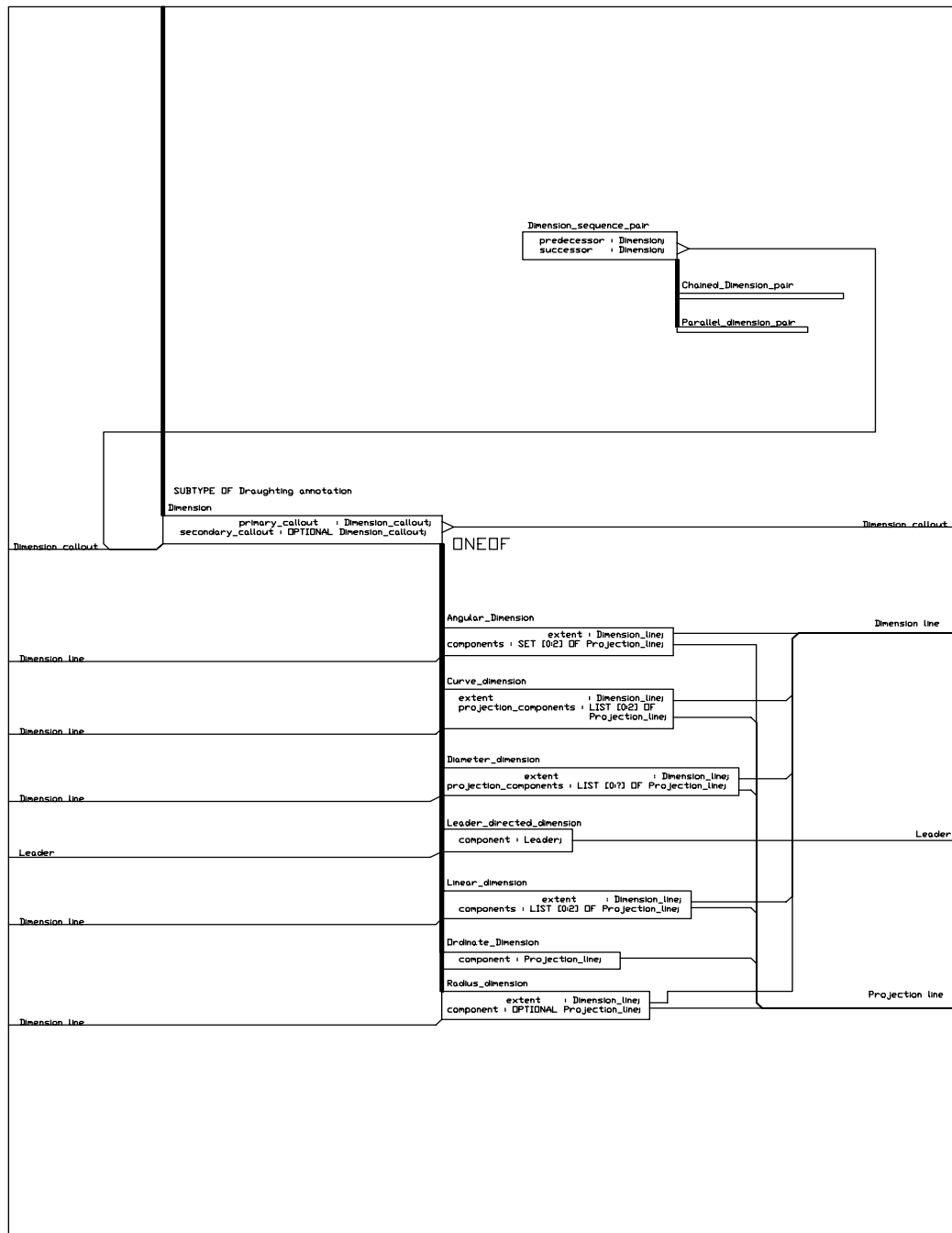


Figure 12 – Conventional Dimensions

:

secondary_callout: The **Dimension_callout** which is the secondary callout for this **Dimension**.

NOTE – The primary callout is the dimension value, tolerance information, and any associated notes specified in the primary unit of measure for that **Drawing-view**, **Drawing-sheet**, or **Drawing**. The secondary callout is the same information specified in a second unit of measure. The primary callout could be in millimeters and the secondary in inches.

2.11.2 Angular_Dimension

An **Angular_Dimension** is a type of **Dimension** that is the graphical presentation of a value of the angle between two elements that converge on a common point or line.

EXPRESS specification:

```
*)  
ENTITY Angular_dimension  
SUBTYPE OF Dimension;  
extent : Dimension_line;  
components : SET [0:2] OF Projection_line;  
END_ENTITY;  
(*
```

Attribute definitions:

extent: the extent of this **Angular_Dimension**.

components: the components of this **Angular_Dimension**.

2.11.3 Chained_Dimension_pair

A **Chained_Dimension_pair** is a type of **Dimension_sequence_pair** that is the relationship between two **Dimensions** in which the terminus of one **Dimension** initializes the next **Dimension** in the sequence.

EXPRESS specification:

```
*)  
ENTITY Chained_Dimension_pair  
SUBTYPE OF (Dimension_sequence_pair);  
END_ENTITY;  
(*
```

2.11.4 Curve_dimension

A **Curve_dimension** is a type of **Dimension** that is the graphical presentation of a value of the distance between two elements, measured along a curved path, or the length of a curved element.

EXPRESS specification:

```
*)  
ENTITY Curve_dimension
```


:

```
SUBTYPE OF ( Dimension );
    extent          : Dimension_line;
    projection_components : LIST [0:2] OF Projection_line;
END_ENTITY;
(*
```

Attribute definitions:

extent: The **Dimension_line** giving the extent of this **Curve_dimension**.

projection_components: The set of **Projection_lines** which are components of this **Curve_dimension**.

2.11.5 Diameter_dimension

A **Diameter_dimension** is a type of **Dimension** that is the graphical presentation of a value of the diametrical size of a circular element.

EXPRESS specification:

```
*)
ENTITY Diameter_dimension
SUBTYPE OF (Dimension);
    extent          : Dimension_line;
    projection_components : LIST [0:?] OF Projection_line;
END_ENTITY;
(*
```

Attribute definitions:

extent: A **Dimension_line** giving the extent of the **Diameter_dimension**.

projection_components: A set of **Projection_lines** which are components of this **Diameter_dimension**.

2.11.6 Dimension_sequence_pair

A **Dimension_sequence_pair** is the relationship between two adjacent **Dimensions** that share a **Projection—line**.

EXPRESS specification:

```
*)
ENTITY Dimension_sequence_pair
SUPERTYPE OF (ONEOF (Chained_Dimension_pair,
                     Parallel_dimension_pair));
    predecessor : Dimension;
    successor   : Dimension;
END_ENTITY;
(*
```

Attribute definitions:

predecessor: The **Dimension** which is the predecessor in the relationship being represented by this **Dimension_sequence_pair**.

:

successor: The **Dimension** which is the successor in the relationship being represented by this **Dimension_sequence_pair**.

2.11.7 Leader_directed_dimension

A **Leader_directed_dimension** is a type of **Dimension** that is the graphical presentation of a dimension value and is guided to the feature being dimensioned with a **Leader**.

EXPRESS specification:

```
*)  
ENTITY Leader_directed_dimension  
SUBTYPE OF (Dimension);  
    component : Leader;  
END_ENTITY;  
(*
```

Attribute definitions:

component: the **Leader** object which has this **Leader_directed_dimension** as a component.

2.11.8 Linear_dimension

A **Linear_dimension** is a type of **Dimension** that is the graphical presentation of a value of linear distance measured between two points along a straight path.

EXPRESS specification:

```
*)  
ENTITY Linear_dimension  
SUBTYPE OF (Dimension);  
    extent      : Dimension_line;  
    components  : LIST [0:2] OF Projection_line;  
END_ENTITY;  
(*
```

Attribute definitions:

extent: the **Dimension_line** which shows the extent of this **Linear_dimension**.

components: the set of **Projection_line** objects which act as components of this **Linear_dimension**.

2.11.9 Ordinate_Dimension

An **Ordinate_Dimension** is a type of **Dimension** that is the graphical presentation of a value of linear distance measure where the linear distance is parallel to an axis of the coordinate system of the item being dimensioned. The origin or datum of the **Ordinate_dimension** is a point, line, or plane surface corresponding to or coincident with an axis in the plane of the dimension and perpendicular to the direction of measurement. Only the terminus of the dimension extent is indicated by a **Projection_line** parallel to the datum, the dimension value, and associated information.

:

EXPRESS specification:

```
*)  
ENTITY Ordinate_Dimension  
SUBTYPE OF ( Dimension);  
    component : Projection_line;  
END_ENTITY;  
(*
```

Attribute definitions:

component: the **Projection_line** which is a component of this **Ordinate_Dimension**.

2.11.10 Parallel_dimension_pair

A **Parallel_dimension_pair** is a type of **Dimension_sequence_pair** that is the relationship between two **Dimensions** of the same type, wherein their dimension lines are parallel and share a common baseline or datum.

EXPRESS specification:

```
*)  
ENTITY Parallel_dimension_pair  
SUBTYPE OF (Dimension_sequence_pair);  
END_ENTITY;  
(*
```

2.11.11 Radius_dimension

A **Radius_dimension** is a type of **Dimension** that is the graphical presentation of the value of the radial distance from the centre of a circular element to a point on the element.

EXPRESS specification:

```
*)  
ENTITY Radius_dimension  
SUBTYPE OF (Dimension );  
    extent      : Dimension_line;  
    component : OPTIONAL Projection_line;  
END_ENTITY;  
(*
```

Attribute definitions:

extent: the **Dimension_line** which shows the extent of this **Radius_dimension**.

component: the **Projection_line** which is a component of this **Radius_dimension**.

2.12 Associative Dimensions

The Associative Dimension group contains those dimension entities which relate to the model geometry. It includes **Annotation_elements** pertaining to geometric tolerancing. Entities related to Associative Dimensions are shown in Figure 13.

:

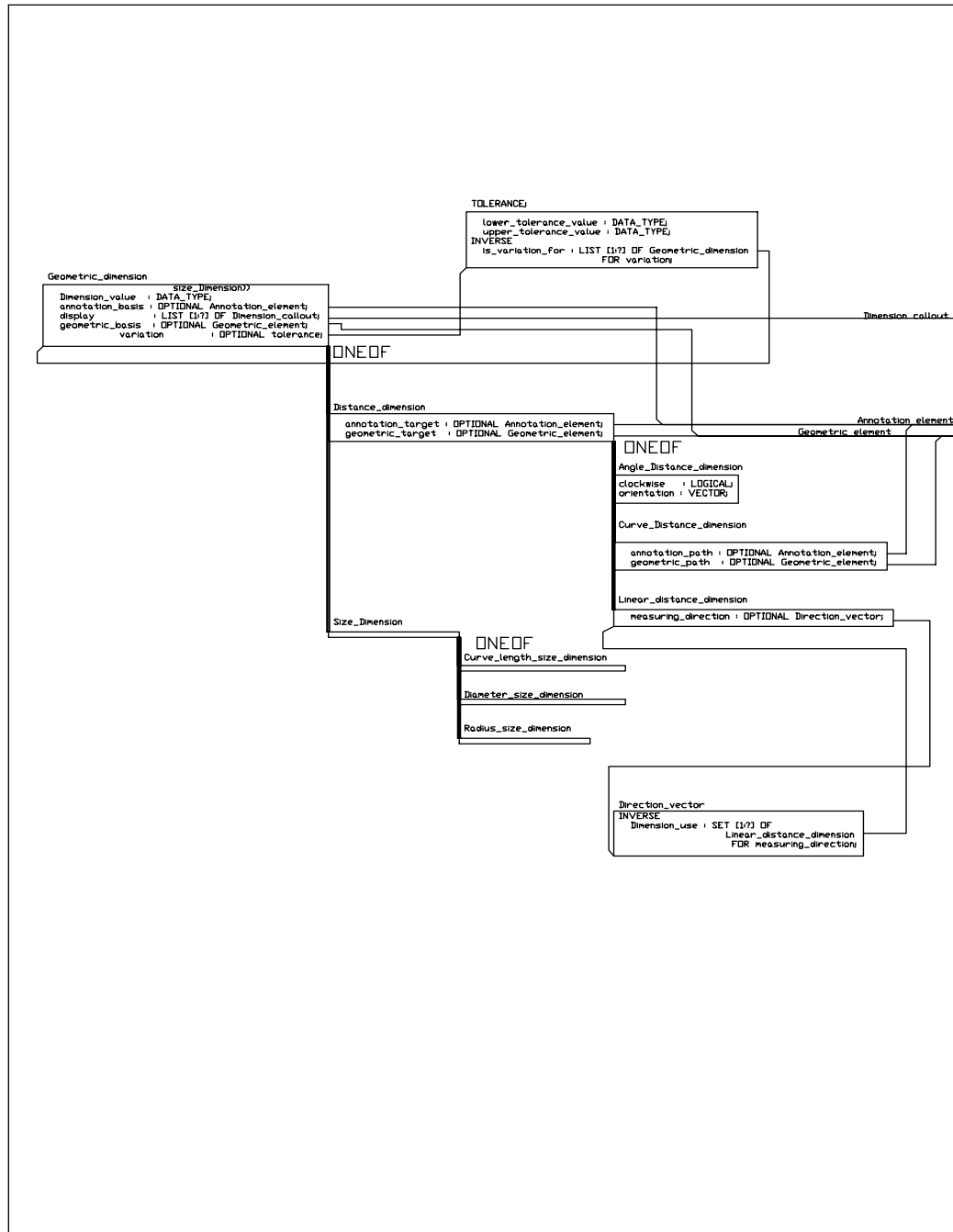


Figure 13 – Associative Dimensions

2.12.1 Angle_distance_dimension

An **Angle_distance_dimension** is a type of **Distance_dimension** where the distance is calculated between two elements converging on a common point or line, measured in units of angle measure.

EXPRESS specification:

```
*)
ENTITY Angle_distance_dimension
SUBTYPE OF (Distance_dimension);
    clockwise    : LOGICAL;
    orientation  : VECTOR;
END_ENTITY;
(*
```

Attribute definitions:

clockwise: whether or not the dimension is measured in a clockwise direction from the geometric basis element to the geometric target element.

orientation: the vector that defines the right-hand rule to be used in determining the direction of measurement specified by the clockwise attribute.

2.12.2 Curve_Distance_dimension

A **Curve_Distance_dimension** is a type of **Distance_dimension** where the distance is calculated between two elements along a path defined by a third element of geometry or annotation.

EXPRESS specification:

```
*)
ENTITY Curve_Distance_dimension
SUBTYPE OF (Distance_dimension);
    annotation_path : OPTIONAL Annotation_element;
    geometric_path  : OPTIONAL Geometric_element;
END_ENTITY;
(*
```

Attribute definitions:

annotation_path: a path for the **Curve_Distance_dimension** which is provided by an **Annotation_element**.

geometric_path: a path for the **Curve_Distance_dimension** which is provided by a **Geometric_element**.

2.12.3 Curve_length_size_dimension

A **Curve_length_size_dimension** is a type of **Size_dimension** where the element to be measured is a curve and the measurement is to be along the entire path of the curve.

EXPRESS specification:

:

```
*)  
ENTITY Curve_length_size_dimension  
SUBTYPE OF (Size_dimension);  
END_ENTITY;  
(*
```

2.12.4 Diameter_size_dimension

A **Diameter_size_dimension** is a type of **Size_dimension** where the element to be measured is circular in definition and the measurement is the diametrical distance between two points on the element.

EXPRESS specification:

```
*)  
ENTITY Diameter_size_dimension  
SUBTYPE OF (size_dimension);  
END_ENTITY;  
(*
```

2.12.5 Direction_vector

A **Direction_vector** is a vector that determines the linear course along which to measure a **Linear_distance_dimension**. The vector is defined in the coordinate space of the elements being measured. The magnitude of the vector shall be of unit length one. The magnitude does not affect the measurement of the **Linear_distance_dimension**.

EXPRESS specification:

```
*)  
ENTITY Direction_vector  
SUBTYPE OF ( vector);  
INVERSE  
    Dimension_use : SET [1:?] OF Linear_distance_dimension  
                    FOR measuring_direction;  
END_ENTITY;  
(*
```

Attribute definitions:

Dimension_use: The **Linear_distance_dimension** which uses this **Direction_vector** as its **measuring_direction**.

2.12.6 Distance_dimension

A **Distance_dimension** is a type of **Geometric_dimension** that is a calculation of the distance between two elements of geometry or annotation.

EXPRESS specification:

```
*)  
ENTITY Distance_dimension  
SUPERTYPE OF (ONEOF (Angle_Distance_dimension,
```

:

```
Curve_Distance_dimension,  
Linear_distance_dimension))  
SUBTYPE OF (Geometric_dimension);  
  annotation_target : OPTIONAL Annotation_element;  
  geometric_target  : OPTIONAL Geometric_element;  
END_ENTITY;  
(*
```

Attribute definitions:

annotation_target: The geometric target for this **Distance_dimension** which may be provided by an **Annotation_element**.

geometric_target: The geometric target for this **Distance_dimension** which may be provided by a **Geometric_element**.

2.12.7 Geometric_dimension

A **Geometric_dimension** is the result of a calculation of the size of an element or the distance between two elements. This calculation is prescribed according to draughting standards and practices.

NOTES

1 – A **Geometric_dimension** is presented by a **Dimension**, showing the dimension value and its relationship to the draughted geometry or annotation.

2 – The numeric **Dimension_value** of a **Geometric_dimension** need not be identical to the textual dimension value as presented in a **Dimension_callout** .

EXPRESS specification:

```
*)  
ENTITY Geometric_dimension  
SUPERTYPE OF (ONEOF (Distance_dimension,  
                      size_Dimension))  
  dimension_value : DATA_TYPE;  
  annotation_basis : OPTIONAL Annotation_element;  
  display         : LIST [1:?] OF Dimension_callout;  
  geometric_basis : OPTIONAL Geometric_element;  
  variation       : OPTIONAL Tolerance;  
END_ENTITY;  
(*
```

Attribute definitions:

dimension_value: the value resulting from the measurement of the size of an element or the measurement of the distance between two elements.

annotation_basis: the **Annotation_element** which provides a geometric basis for this **Geometric_dimension**.

display: the set of **Dimension_callout** objects which display this **Geometric_dimension**.

:

geometric_basis: the **Geometric_element** which provides the geometric basis for this **Geometric_dimension**.

variation: the **Tolerance** which specifies the variation for this **Geometric_dimension**.

2.12.8 Linear_distance_dimension

A **Linear_distance_dimension** is a type of **Distance_dimension** where the distance is calculated between two elements along a linear path.

EXPRESS specification:

```
*)  
ENTITY Linear_distance_dimension  
SUBTYPE OF (Distance_dimension);  
    measuring_direction : OPTIONAL Direction_vector;  
END_ENTITY;  
(*
```

Attribute definitions:

measuring_direction: the **Direction_vector** which indicates the direction of measurement for this **Linear_distance_dimension**.

NOTE – A **Direction_vector** is not necessary if the distance between the two elements is measured along the shortest path.

2.12.9 Radius_size_dimension

A **Radius_size_dimension** is a type of **Size_Dimension** where the element is circular in nature and the calculation is to be the distance from the centre to any point on the element.

EXPRESS specification:

```
*)  
ENTITY Radius_size_dimension  
SUBTYPE OF (Size_dimension);  
END_ENTITY;  
(*
```

2.12.10 Size_dimension

A **Size_dimension** is a type of **Geometric_dimension** that is a measurement of some characteristic of size for an individual **Geometric_element** or **Annotation_element**.

NOTE – A chordal length is a measurement of size, although treated as the distance between two points on a circular arc.

EXAMPLES

11 – Characteristics of size for circular arc geometry are radius, diameter, and arc length.

EXPRESS specification:

:

```
*)
ENTITY Size_dimension
SUPERTYPE OF (ONEOF (Curve_length_size_dimension,
                     Diameter_size_dimension,
                     Radius_size_dimension))
SUBTYPE OF (Geometric_dimension);
END_ENTITY;
(*
```

2.12.11 Tolerance

A **Tolerance** is the permissible deviation of a Dimension value from the theoretically exact value.

EXPRESS specification:

```
*)
ENTITY Tolerance;
    lower_tolerance_value : DATA_TYPE;
    upper_tolerance_value : DATA_TYPE;
INVERSE
    is_variation_for : LIST [1:?] OF Geometric_dimension
                     FOR variation;
END_ENTITY;
(*
```

Attribute definitions:

lower_tolerance_value: the allowable deviation of a nominal dimension value whereby the resulting Dimension value is at its smallest value.

upper_tolerance_value: the allowable deviation of a nominal dimension value whereby the resulting dimension value is at its largest value.

is_variation_for: the set of **Geometric_dimension** objects whose variation is defined by this **Tolerance**.

2.13 Dimension Component

The Dimension Component group includes entities which define portions of dimensions, but are seldom used alone. Entities of the Dimension Component group are shown in Figure 14.

2.13.1 Dimension_line

A **Dimension_line** is a type of **Directed_curve** used in the graphical presentation of a Dimension value along with other symbology, if necessary, to show the extent of the application of the value.

EXAMPLES

:

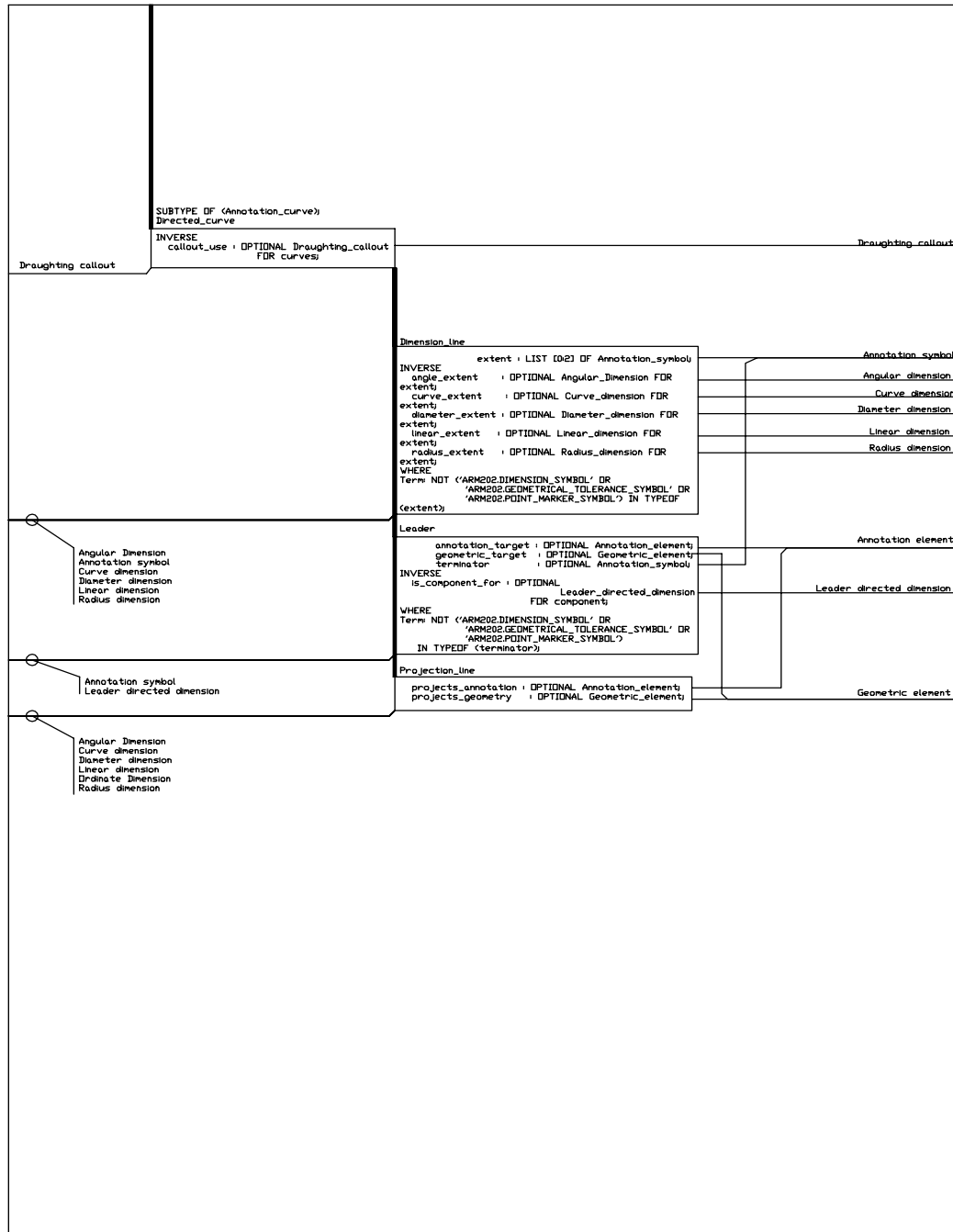


Figure 14 – Dimension Components

:

12 – Terminators or symbols which indicate a foreshortened line may be associated with a **Dimension_line**.

EXPRESS specification:

```
*)
ENTITY Dimension_line
SUBTYPE OF (Directed_curve);
  extent : LIST [0:2] OF Annotation_symbol;
INVERSE
  angle_extent      : OPTIONAL Angular_dimension
                    FOR extent;
  curve_extent      : OPTIONAL Curve_dimension
                    FOR extent;
  diameter_extent   : OPTIONAL Diameter_dimension
                    FOR extent;
  linear_extent     : OPTIONAL Linear_dimension
                    FOR extent;
  radius_extent     : OPTIONAL Radius_dimension
                    FOR extent;
WHERE
Term: NOT ('ARM202.DIMENSION_SYMBOL' OR
           'ARM202.GEOMETRICAL_TOLERANCE_SYMBOL' OR
           'ARM202.POINT_MARKER_SYMBOL')
      IN TYPEOF (extent);
END_ENTITY;
(*
```

Attribute definitions:

extent: The **Annotation_symbols** which indicate the extent of the **Dimension_line**.

angle_extent: An **Angular_Dimension** whose extent may be indicated by this **Dimension_line**.

curve_extent: A **Curve_dimension** whose extent may be indicated by this **Dimension_line**.

diameter_extent: A **Diameter_dimension** whose extent may be indicated by this **Dimension_line**.

linear_extent: A **Linear_dimension** whose extent may be indicated by this **Dimension_line**.

radius_extent: A **Radius_dimension** whose extent may be indicated by this **Dimension_line**.

Formal propositions:

Term: If the extent of this Dimension line is determined by an **Annotation_symbol** of SUB-TYPE **Pre_defined_symbol** , it shall be only of type **Terminator_symbol**.

:

2.13.2 Directed_curve

A **Directed_curve** is a type of **Annotation_curve** that is used to guide annotation to a specific feature or area of a **Draughting_shape_model**, **Drawing_view**, or **Drawing_sheet**.

EXPRESS specification:

```
*)
ENTITY Directed_curve
SUPERTYPE OF (ONEOF (Dimension_line,
                     Leader,
                     Projection_line))
SUBTYPE OF (Annotation_curve);
INVERSE
    callout_use : OPTIONAL Draughting_callout
                FOR curves;
END_ENTITY;
(*
```

Attribute definitions:

callout_use: The **Draughting_callout** which uses this **Directed_curve** as one of its curves.

2.13.3 Leader

A **Leader** is a type of **Directed_curve** that directs a dimension, a note, or a symbol to the intended place or point on a feature appearing on the **Drawing** or in the **Draughting_shape_model**.

NOTE – Information in a **Draughting_callout** may be associated and visually directed to an **Annotation_element** by means of a **Leader**. The associativity of **Dimensions** is accomplished by means of a **Geometric_dimension**, not by the association of a **Leader** to an **Annotation_element**.

EXPRESS specification:

```
*)
ENTITY Leader
SUBTYPE OF (Directed_curve);
    annotation_target : OPTIONAL Annotation_element;
    geometric_target  : OPTIONAL Geometric_element;
    terminator        : OPTIONAL Annotation_symbol;
INVERSE
    is_component_for : OPTIONAL Leader_directed_dimension
                    FOR component;
WHERE
Term: NOT ('ARM202.DIMENSION_SYMBOL' OR
           'ARM202.GEOMETRICAL_TOLERANCE_SYMBOL' OR
           'ARM202.POINT_MARKER_SYMBOL')
      IN TYPEOF (terminator);
END_ENTITY;
(*
```

Attribute definitions:

annotation_target: the **Annotation_element** which may be a target for this **Leader**.

:

geometric_target: the **Geometric_element** which may be a target for this **Leader**.

terminator: the **Annotation_symbol** object which terminates this **Leader**.

is_component_for: a **Leader_directed_dimension** for which this **Leader** is a component.

Formal propositions:

Term: If this **Leader** is terminated by an **Annotation_symbol** of SUBTYPE **Pre_defined_symbol**, it shall be only of type **Terminator_symbol**.

2.13.4 Projection_line

A **Projection_line** is a type of **Directed_curve** that represents the extension of a point, line, surface, or theoretical point of intersection to a location outside the part outline.

NOTE – Information in a **Draughting_callout** may be associated and visually directed to an **Annotation_element** by means of a **Projection_line**. The associativity of **Dimensions** is accomplished by means of a **Geometric_dimension**, not by the association of a **Projection_line** to an **Annotation_element**.

EXPRESS specification:

```
*)
ENTITY Projection_line
SUBTYPE OF (Directed_curve);
    projects_annotation : OPTIONAL Annotation_element;
    projects_geometry   : OPTIONAL Geometric_element;
END_ENTITY;
(*
```

Attribute definitions:

projects_annotation: the **Annotation_element** which is projected by this **Projection_line**.

projects_geometry: the **Geometric_element** which is projected by this **Projection_line**.

2.14 Draughting Callout

The Draughting Callout group includes entities which define text notes on a **Drawing**. Entities in the Draughting Callout group are shown in Figure 15.

2.14.1 Draughting_callout

A **Draughting_callout** is a type of **Draughting_annotation** that is a combination of **Text**, **Annotation_curves**, and symbology which conveys information about a specific feature or area.

EXPRESS specification:

```
*)
ENTITY Draughting_callout
SUPERTYPE OF    Unstructured_dimension_callout
    ANDOR (ONEOF (Datum_feature_callout,
```

:

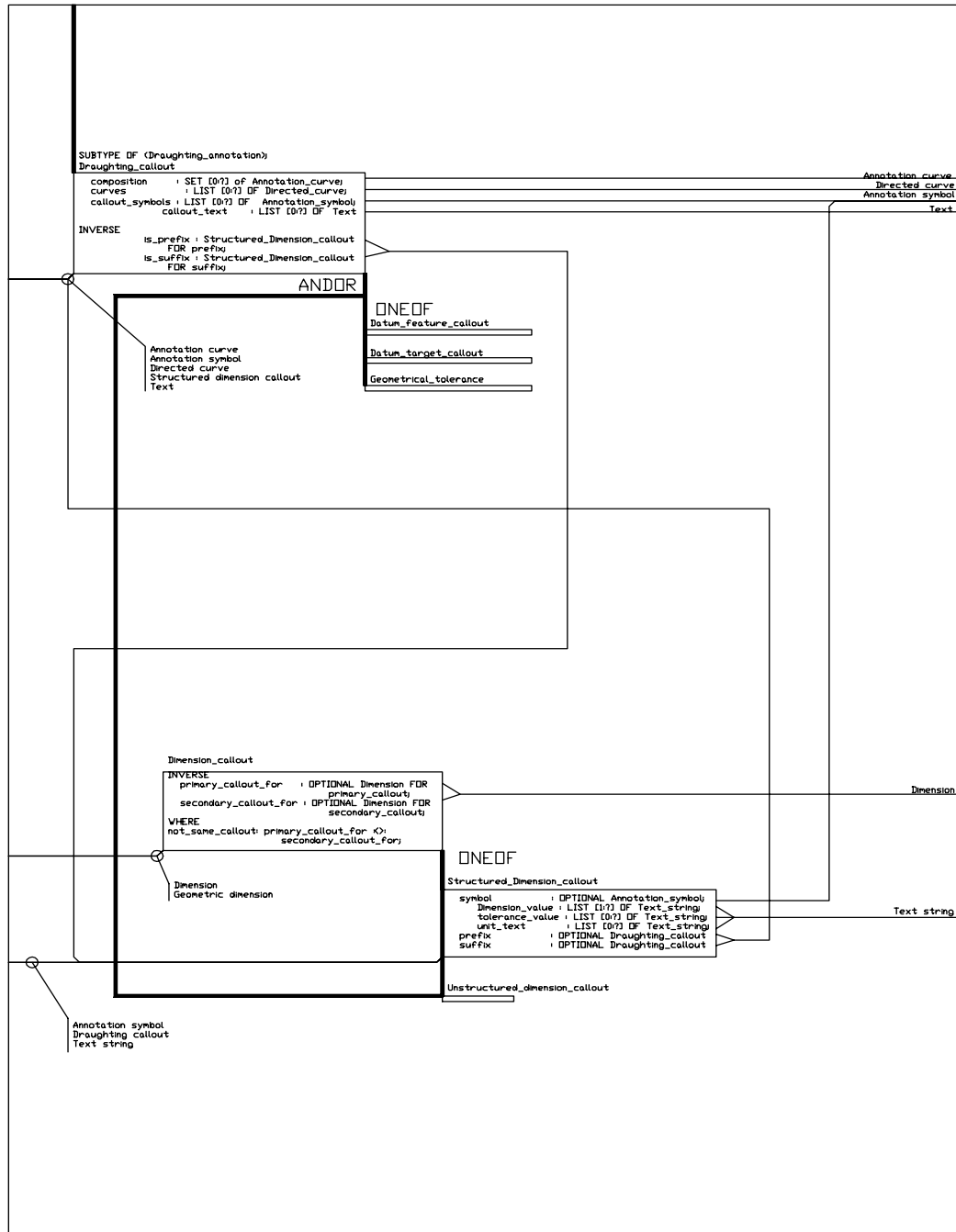


Figure 15 – Draughting Callout

:

```

Datum_target_callout,
Geometrical_tolerance))
SUBTYPE OF (Draughting_annotation);
  composition      : SET [0:?] OF Annotation_curve;
  curves           : LIST [0:?] OF Directed_curve;
callout_symbols : LIST [0:?] OF Annotation_symbol;
  callout_text     : LIST [0:?] OF Text;
INVERSE
  is_prefix : Structured_dimension_callout
            FOR prefix;
  is_suffix : Structured_dimension_callout
            FOR suffix;
END_ENTITY;
(*)

```

Attribute definitions:

composition: the **Annotation_curve** objects which compose this **Draughting_callout**.

curves: The set of **Directed_curve** entities which direct this **Draughting_callout**.

callout_symbols: The **Annotation_symbols** which compose this **Draughting_callout**.

callout_text: The **Text** entities which compose this **Draughting_callout**.

is_prefix: The **Structured_dimension_callout** for which this **Draughting_callout** is a prefix.

is_suffix: The **Structured_dimension_callout** for which this **Draughting_callout** is a suffix.

2.14.2 Datum_feature_callout

A **Datum_feature_callout** is a type of **Draughting_callout** used to denote a point, line, or plane as a datum and which specifies the designation to be used as identification of that datum.

EXPRESS specification:

```

*)
ENTITY Datum_feature_callout
SUBTYPE OF (Draughting_callout);
END_ENTITY;
(*)

```

2.14.3 Datum_target_callout

A **Datum_target_callout** is a type of **Draughting_callout** used to denote points, lines, and surfaces of contact, on a product, which are used in establishing a reference datum. The callout contains an alphanumeric designation and, where applicable, a specification of the diametrical size of the target area.

EXPRESS specification:

:

```
*)  
ENTITY Datum_target_callout  
SUBTYPE OF (Draughting_callout);  
END_ENTITY;  
(*
```

2.14.4 Dimension_callout

A **Dimension_callout** is the text and symbols in the presentation of a **Dimension** that represent the dimension value, dimension units, tolerance information and any related notes.

EXPRESS specification:

```
*)  
ENTITY Dimension_callout  
SUPERTYPE OF (ONEOF (Structured_dimension_callout,  
                      Unstructured_dimension_callout));  
INVERSE  
    primary_callout_for : OPTIONAL Dimension  
                        FOR primary_callout;  
    secondary_callout_for : OPTIONAL Dimension  
                        FOR secondary_callout;  
WHERE  
not_same_callout: primary_callout_for :<>:  
                  secondary_callout_for;  
END_ENTITY;  
(*
```

Attribute definitions:

primary_callout_for: The **Dimension** for which this **Dimension_callout** is the primary callout.

secondary_callout_for: The **Dimension** for which this **Dimension_callout** is the secondary callout.

NOTE – The primary callout is the dimension value, tolerance information, and any associated notes specified in the primary unit of measure for that **Drawing_view**, **Drawing_sheet**, or **Drawing**. The secondary callout is the same information specified in a second unit of measure. The primary callout could be in millimeters and the secondary in inches.

Formal propositions:

not_same_callout_for: A **Dimension_callout** shall not be both the **primary_callout** and the **secondary_callout** for the same **Dimension**.

2.14.5 Geometrical_tolerance

A **Geometrical_tolerance** is a type of **Draughting_callout** that is the human-interpretable presentation of tolerance information. This presentation is a combination of geometric characteristic symbols, tolerance values, and datum reference designations, where applicable, to express

the permissible variation from the theoretically exact size, profile, orientation, or location of a feature or datum target.

EXPRESS specification:

```
*)
ENTITY Geometrical_tolerance
SUBTYPE OF (Draughting_callout);
END_ENTITY;
(*
```

2.14.6 Structured_Dimension_callout

A **Structured_Dimension_callout** is a type of **Dimension_callout** wherein each component is identified as having the semantics of prefix information, suffix information, a dimension symbol, a dimension unit, a dimension value, or tolerance information.

EXPRESS specification:

```
*)
ENTITY Structured_dimension_callout
SUBTYPE OF (Dimension_callout);
    symbol          : OPTIONAL Annotation_symbol;
    dimension_value : LIST [1:?] OF Text_string;
    tolerance_value : LIST [0:?] OF Text_string;
    unit_text       : LIST [0:?] OF Text_string;
    prefix          : OPTIONAL Draughting_callout
    suffix          : OPTIONAL Draughting_callout
END_ENTITY;
(*
```

Attribute definitions:

symbol: the **Annotation_symbol** which is a symbol for this **Structured_dimension_callout**.

dimension_value: the set of **Dimension_text_string** objects which are the Dimension value for this **Structured_dimension_callout**.

tolerance_value: the set of **Text_string** objects which give the tolerance value for this **Structured_dimension_callout**.

unit_text: the set of **Text_string** objects which give the unit text for this **Structured_dimension_callout**.

prefix: the **Draughting_callout** which is the prefix for this **Structured_dimension_callout**.

suffix: the **Draughting_callout** which is the suffix for this **Structured_dimension_callout**.

:

2.14.7 Unstructured_dimension_callout

An **Unstructured_dimension_callout** is a type of **Dimension_callout** in which a single **Draughting_callout** is used and the components of the **Dimension_callout** are not semantically identified.

EXPRESS specification:

```
*)  
ENTITY Unstructured_dimension_callout  
SUBTYPE OF (Dimension_callout, Draughting_callout);  
END_ENTITY;  
(*
```

2.15 Draughting Annotation Symbol

The Draughting Annotation Symbol group contains entities which define symbols pertaining strictly to the draughting application. Entities in the Draughting Annotation Symbol group are shown in Figure 16.

2.15.1 Dimension_symbol

A **Dimension_symbol** is a type of **Predefined_symbol** that is used in conjunction with a **Dimension_value** to convey the context of the **Dimension_value**.

EXAMPLES

13 – A diameter symbol may be used in conjunction with a dimension value to denote a diameter dimension.

EXPRESS specification:

```
*)  
ENTITY Dimension_symbol  
SUBTYPE OF (Predefined_symbol);  
END_ENTITY;  
(*
```

2.15.2 Geometrical_tolerance_symbol

A **Geometrical_tolerance_symbol** is a type of **Predefined_symbol** that is used to establish a tolerance zone within which the specified conditions of the tolerance apply.

EXPRESS specification:

```
*)  
ENTITY Geometrical_tolerance_symbol  
SUBTYPE OF (Predefined_symbol);  
END_ENTITY;  
(*
```

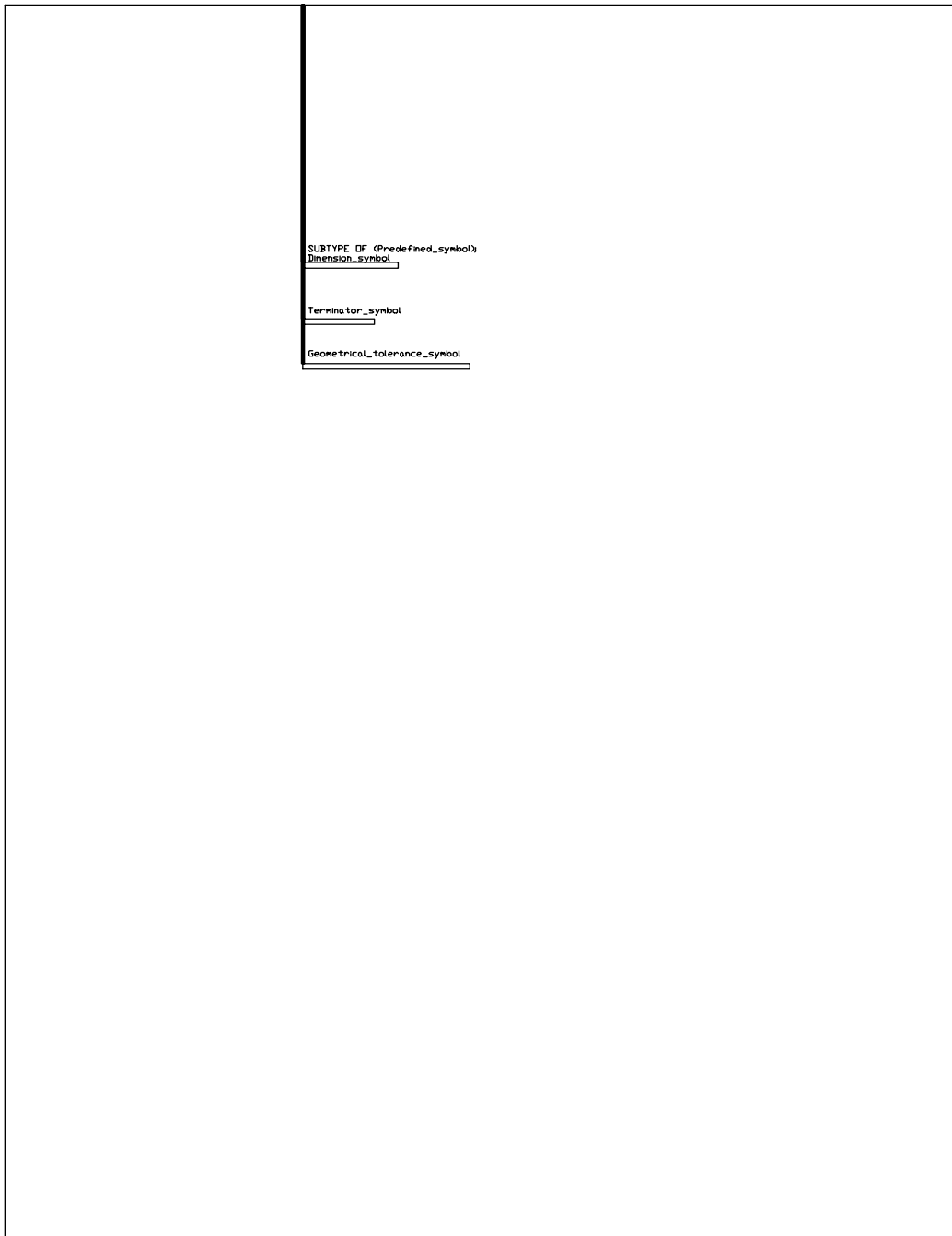


Figure 16 – Draughting Annotation Symbols

:

2.15.3 Terminator_symbol

A **Terminator_symbol** is a type of **Predefined_symbol** that is applied to an **Annotation_curve** and used to identify the endpoint or point of application of any annotation directed by that curve.

EXPRESS specification:

```
*)  
ENTITY Terminator_symbol  
SUBTYPE OF (Predefined_symbol);  
END_ENTITY;  
(*
```

2.16 Annotation Placement

The Annotation Placement group contains those entities which govern the placement of annotation in one of three environments, the model, a view of the model, or a sheet of a drawing. Entities in the Annotation Placement group are shown in Figure 17.

2.16.1 Model_placed_annotation

A **Model_placed_annotation** is a type of **Draughting_annotation** that is located in the coordinate system of the **Draughting_shape_model** and is subject to view transformations for display.

NOTES

1 – Although this application protocol allows for the placement of annotation in 3-dimensional space, all annotation is limited to be 2-dimensional and planar. There is no limitation on where the plane is located in 3-dimensional space.

2 – The appearance of an element for a specific visual presentation is governed by the last set of appearance characteristics assigned to it. Appearance characteristics assigned after the element has been defined with a set of appearance characteristics will override those which are part of the definition. Each new set of characteristics which are assigned will override those previously assigned. However, when an element is instanced or viewed through a viewing pipeline, the appearance characteristics assigned for that instance or view only apply to that instance or view and will not alter the original definition of that element.

EXPRESS specification:

```
*)  
ENTITY Model_placed_annotation  
SUBTYPE OF (Draughting_annotation);  
  layers      : LIST [1:?] OF Layer;  
  visibility  : OPTIONAL Invisibility;  
INVERSE  
  is_contained_in : Draughting_shape_model  
                  FOR model_annotation;  
END_ENTITY;  
(*
```

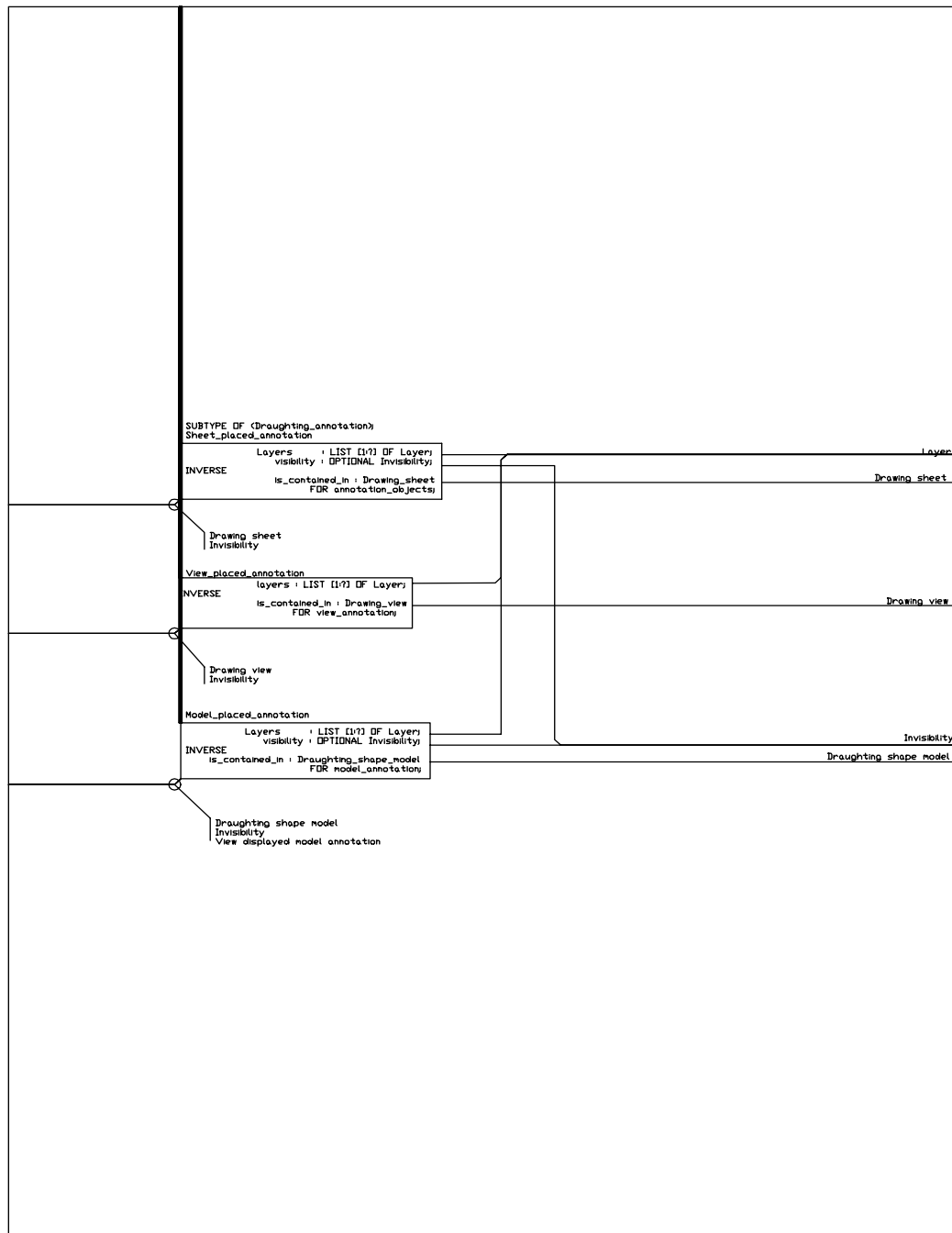


Figure 17 – Annotation Placement

:

Attribute definitions:

layers: the set of **Layer** objects which contain this **Model_placed_annotation**.

visibility: a possible **Invisibility** object which governs the display of this **Model_placed_annotation**.

is_contained_in: the **Draughting_shape_model** in which this **Model_placed_annotation** is contained.

2.16.2 Sheet_placed_annotation

A **Sheet_placed_annotation** is a type of **Draughting_annotation** that is located in the coordinate system of the **Drawing_sheet**.

EXPRESS specification:

```
*)
ENTITY Sheet_placed_annotation
SUBTYPE OF (Draughting_annotation);
  layers      : LIST [1:?] OF Layer;
  visibility  : OPTIONAL Invisibility;
INVERSE
  is_contained_in : Drawing_sheet
                  FOR annotation_objects;
END_ENTITY;
(*
```

Attribute definitions:

layers: the set of **Layer** objects in which this **Sheet_placed_annotation** is contained.

is_contained_in: the **Drawing_sheet** which contains this **Sheet_placed_annotation**.

visibility: a possible **Invisibility** object which governs the display of this **Sheet_placed_annotation**.

2.16.3 View_placed_annotation

A **View_placed_annotation** is a type of **Draughting_annotation** that is located in the coordinate system of the **Drawing_view**.

EXPRESS specification:

```
*)
ENTITY View_placed_annotation
SUBTYPE OF (Draughting_annotation);
  layers : LIST [1:?] OF Layer;
INVERSE
  is_contained_in : Drawing_view
                  FOR view_annotation;
END_ENTITY;
(*
```

:

Attribute definitions:

layers: the set of **Layer** objects which contain this **View_placed_annotation**.

is_contained_in: the **Drawing_view** which contains this **View_placed_annotation**.

2.17 Appearance

The Appearance group contains entities defining the physical appearance of elements on a drawing, as opposed to the structure of these elements.

2.17.1 Appearance

An Appearance is a collection of visual characteristics that govern the presentation of **Geometric_elements** or **Annotation_elements**. The **Appearance** entity is shown in Figure 18.

EXPRESS specification:

```
*)
ENTITY Appearance
SUPERTYPE OF (Curve_appearance,
               Fill_area_appearance,
               Text_appearance)
END_ENTITY;
(*
```

2.18 Curve Appearance

The Curve Appearance group contains entities which govern the appearance of elements of a **Drawing** depicting curves. Entities in the Curve Appearance group are shown in Figure 19.

2.18.1 Curve_appearance

A **Curve_appearance** is a type of **Appearance** that governs the visual presentation of geometric curves and **Annotation_curves**. Each **Curve_appearance** may be a **Viewed_surface_appearance**.

EXPRESS specification:

```
*)
ENTITY Curve_appearance
SUPERTYPE OF (Viewed_surface_appearance)
SUBTYPE OF (Appearance);
    draughting_role    : OPTIONAL DATA_TYPE;
    width              : DATA_TYPE;
    Colour_definition  : Colour;
    line_definition    : Line_font;
END_ENTITY;
(*
```

:

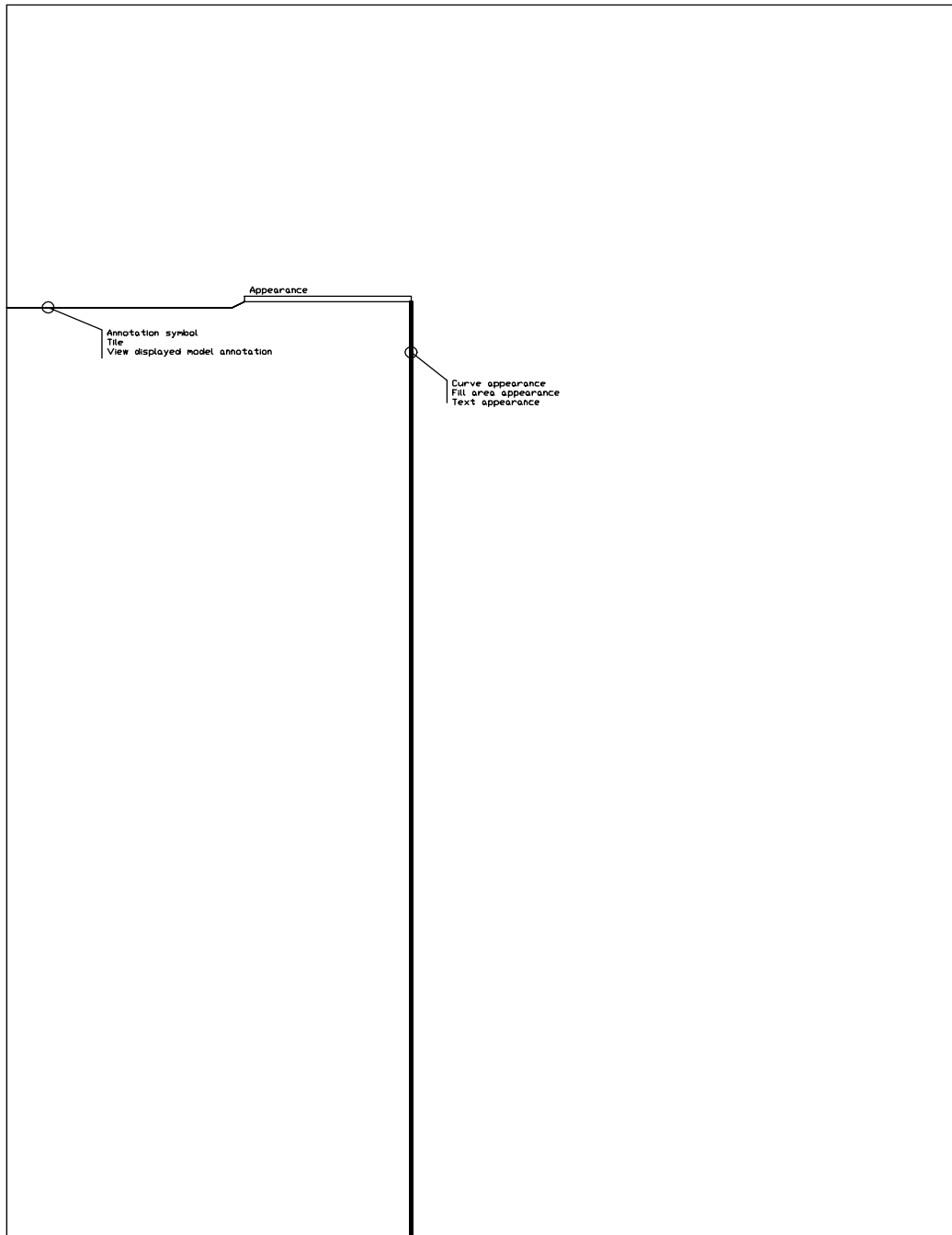


Figure 18 – Appearance

:

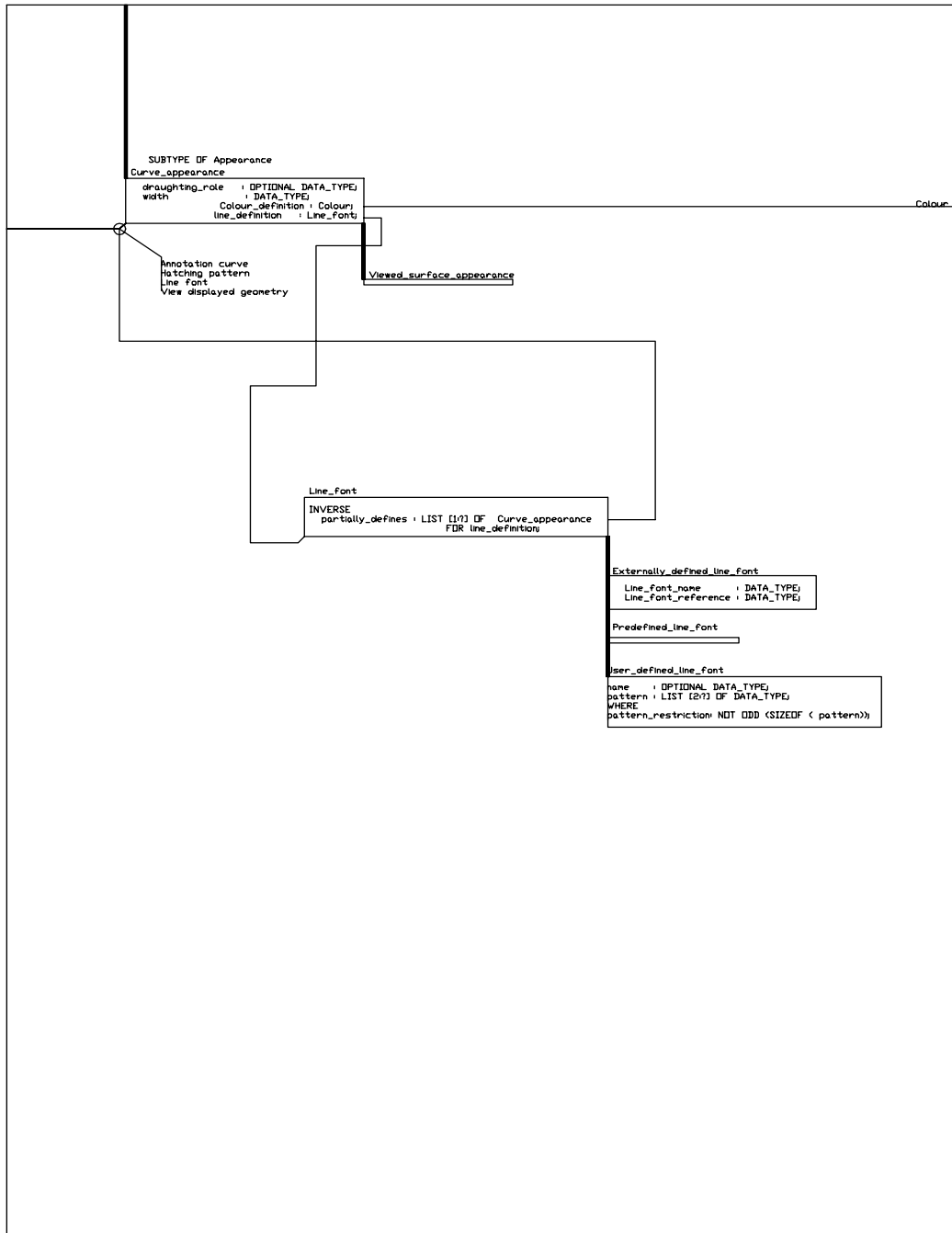


Figure 19 – Curve Appearance

:

Attribute definitions:

draughting_role: the purpose within draughting for a particular **Curve_appearance**. The **draughting_role** need not be specified for a particular **Curve_appearance**.

EXAMPLES

14 – A **draughting_role** could be a centreline or section line.

width: the thickness of the curve measured perpendicular to the direction of the curve. The width of the curve is not affected by scaling.

Colour_definition: The **Colour** which partially defines this **Curve_appearance**.

line_definition: The **Line_font** which partially defines this **Curve_appearance**.

2.18.2 Externally_defined_line_font

An **Externally_defined_line_font** is a type of **Line_font** found in a known source that explicitly defines the **Line_font**. This known source is agreed to by all parties involved in the exchange of the **Drawings** on which the **Line_font** appears. An **Externally_defined_line_font** shall include a set of values which represent the length of the visible and invisible segments of the **Line_font**. The set of values is sufficient to define all elements which constitute a single portion of the curve. This portion is then repeated over the length of the curve.

EXAMPLES

15 – An **Externally_defined_line_font** could be ISO 12011-1, Technical Drawings - Lines - Part 1: Basic Conventions.

EXPRESS specification:

```
*)
ENTITY Externally_defined_line_font
SUBTYPE OF (Line_font);
    line_font_name      : DATA_TYPE;
    line_font_reference : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

line_font_name: the identification of a particular **Line_font** within the known source.

line_font_reference: the known source that contains a set of **Line_fonts** from which the **Line_font** is selected.

2.18.3 Line_font

A **Line_font** is a defined pattern of visible and invisible segments applied to a curve in a repetitive manner.

:

EXPRESS specification:

```
*)
ENTITY Line_font
SUPERTYPE OF (ONEOF (Externally_defined_line_font,
                     Predefined_line_font,
                     User_defined_line_font))
INVERSE
    partially_defines : LIST [1:?] OF Curve_appearance
                      FOR line_definition;
END_ENTITY;
(*
```

Attribute definitions:

partially_defines: the set of **Curve_appearance** objects for which this **Line_font** furnishes a portion of the definition.

2.18.4 Predefined_line_font

A **Predefined_line_font** is a type of **Line_font** that is explicitly defined in ISO 10303.

EXPRESS specification:

```
*)
ENTITY Predefined_line_font
SUBTYPE OF (Line_font);
END_ENTITY;
(*
```

2.18.5 User_defined_line_font

A **User_defined_line_font** is a type of **Line_font** that is defined by an explicit listing of the visible and invisible segments that make up the pattern of the font.

EXPRESS specification:

```
*)
ENTITY User_defined_line_font
SUBTYPE OF (Line_font);
    name      : OPTIONAL DATA_TYPE;
    pattern   : LIST [2:?] OF DATA_TYPE;
WHERE
pattern_restriction: NOT ODD (SIZEOF ( pattern));
END_ENTITY;
(*
```

Attribute definitions:

name: the identification of a particular line font.

pattern: a list of length values of visible and invisible segments.

Formal propositions:

:

pattern_restriction: The number of values in the pattern list is even and greater than, or equal to, two.

2.18.6 Viewed_surface_appearance

A **Viewed_surface_appearance** is a type of **Curve_appearance** that governs the visual presentation of curves that represent the edges of surfaces or solids. These curves are necessary to accurately represent the shape of the model when it is displayed in a view.

EXPRESS specification:

```
*)
ENTITY Viewed_surface_appearance
SUBTYPE OF (Curve_appearance);
END_ENTITY;
(*
```

2.19 Fill Area Appearance

The Fill Area Appearance group contains entities which define the appearance of 2-dimensional areas on a **Drawing**. Entities in the Fill Area Appearance group are shown in Figure 20.

2.19.1 Fill_area_appearance

A **Fill_area_appearance** is a type of **Appearance** that governs the visual presentation of a **Fill_area**.

EXPRESS specification:

```
*)
ENTITY Fill_area_appearance
SUPERTYPE OF ( ONEOF (Externally_defined_hatching,
                      Externally_defined_tiling,
                      Solid_Fill_area,
                      User_defined_hatching,
                      User_defined_tiling))
SUBTYPE OF (Appearance);
    draughting_role : OPTIONAL DATA_TYPE;
INVERSE
application : SET [1:?] OF Fill_area
              FOR fill_Appearance;
END_ENTITY;
(*
```

Attribute definitions:

draughting_role: the purpose within draughting for a particular **Fill_area_appearance**.

EXAMPLES

16 – A **draughting_role** could be any of the following: copper, steel, aluminum, concrete, or lumber.



71

:

application: The **Fill_area** to which this **Fill_area_appearance** applies.

2.19.2 Externally_defined_hatching

An **Externally_defined_hatching** is a type of **Fill_area_appearance** found in a known source that explicitly defines the hatching. This known source is agreed to by all parties involved in the exchange of the **Drawings** on which the **Hatching_pattern** appears. An **Externally_defined_hatching** consists of one or more uniformly spaced geometric patterns. For each pattern, an **Externally_defined_hatching** shall include the specification of the **Curve_appearance**, the angle of the curves in the pattern relative to the x-axis of the coordinate system into which it is placed, and the displacement between adjacent curves in the pattern.

EXPRESS specification:

```
*)
ENTITY Externally_defined_hatching
SUBTYPE OF ( Fill_area_appearance);
    Hatching_name      : DATA_TYPE;
    Hatching_reference : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

Hatching_name: the identification of one particular **Hatching_pattern** within the known source.

Hatching_reference: the known source that contains a set of patterns from which the **Hatching_pattern** is selected.

2.19.3 Externally_defined_Tile

An **Externally_defined_Tile** is a type of **Tile** in which the definition of the **Tile** is found in a known source. This known source is agreed to by all parties involved in the exchange of the **Drawings** on which the **Tile** appears.

EXPRESS specification:

```
*)
ENTITY Externally_defined_Tile
SUBTYPE OF ( Tile);
    tile_name      : DATA_TYPE;
    tile_reference : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

tile_name: the identification of a particular **Tile** in the known source.

tile_reference: the known source that contains a set of **Tiles** from which the **Tile** is selected.

2.19.4 Externally_defined_tiling

An **Externally_defined_tiling** is a type of **Fill_area_appearance** found in a known source that explicitly defines the tiling pattern. This known source is agreed to by all parties involved in the exchange of the **Drawings** on which the tiling appears. An **Externally_defined_tiling** specification shall include the repeat vectors used to define the relative positioning of **Tiles**, the angle of the x-axis of the **Tile** relative to the x-axis of the coordinate system into which it is placed, and the scale of the **Tile** as presented to the **Tile** as defined.

EXPRESS specification:

```
*)
ENTITY Externally_defined_tiling
SUBTYPE OF (Fill_area_appearance );
    tiling_name      : DATA_TYPE;
    tiling_reference : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

tiling_name: the identification of a particular tiling pattern in the known source.

tiling_reference: the known source that contains a set of patterns from which the tiling pattern is selected.

2.19.5 Hatching_pattern

A **Hatching_pattern** is a single, uniformly spaced geometric pattern of lines. The basis of the **Hatching_pattern** is an infinite straight line that is repeated across the fill area and clipped to its boundaries. A **Curve_appearance** is applied to an **Annotation_curve** based on the clipped line.

EXPRESS specification:

```
*)
ENTITY Hatching_pattern;
    angle      : DATA_TYPE;
    displacement : DATA_TYPE;
    appearance  : Curve_appearance;
INVERSE
    user_uses : LIST [1:?] OF User_defined_hatching
                FOR patterns;
END_ENTITY;
(*
```

Attribute definitions:

angle: the angular rotation of the curves of the **Hatching_pattern**, measured counter-clockwise, from the x-axis of the coordinate system into which it is placed.

displacement: a vector that positions the adjacent lines of the **Hatching_pattern** from the current line.

:

appearance: the **Curve_appearance** which specifies the appearance of this **Hatching_pattern**.

user_uses: the set of **User_defined_hatching** objects which use this **Hatching_pattern** in their definition.

2.19.6 Solid_Fill_area

A **Solid_Fill_area** is a type of **Fill_area_appearance** defined by a single **Colour** which uniformly fills the **Fill_area** to which the appearance is applied.

EXPRESS specification:

```
*)
ENTITY Solid_Fill_area
SUBTYPE OF (Fill_area_appearance);
    fill_Colour : Colour;
END_ENTITY;
(*
```

Attribute definitions:

fill_Colour: the **Colour** which defines this **Solid_Fill_area**.

2.19.7 Tile

A **Tile** is a graphical symbol defined within a containment border and used as the content of a tiling pattern. The containment border defines the edges of the **Tile**. All elements contained within the border are duplicated for each **Tile**. **Tiles** are placed within a **Fill_area** adjacently and do not overlap.

EXPRESS specification:

```
*)
ENTITY Tile
SUPERTYPE OF (ONEOF (Externally_defined_Tile ,
                      User_defined_tile));
    overriding_Appearance : LIST [0:?] OF Appearance;
    overriding_Colour      : OPTIONAL Colour;
INVERSE
    use : LIST [1:?] OF User_defined_tiling
        FOR definition;
END_ENTITY;
(*
```

Attribute definitions:

overriding_Appearance: the set of **Appearance** objects which define the appearance of this **Tile**.

overriding_Colour: the **Colour** object which provides an overriding colour for this **Tile** object.

use: the set of **User_defined_tiling** objects which use this **Tile** for their definition.

2.19.8 User_defined_hatching

A **User_defined_hatching** is a type of **Fill_area_appearance** that is defined by an explicit listing of hatch patterns.

EXPRESS specification:

```
*)
ENTITY User_defined_hatching
SUBTYPE OF (Fill_area_appearance);
    patterns : LIST [1:?] OF Hatching_pattern;
END_ENTITY;
(*
```

Attribute definitions:

patterns: the set of **Hatching_pattern** objects which define this **User_defined_hatching**.

2.19.9 User_defined_tile

A **User_defined_tile** is a type of **Tile** that is defined by an explicit listing of the components that make up the **Tile**.

EXPRESS specification:

```
*)
ENTITY User_defined_tile
SUBTYPE OF (Tile);
    definition : User_defined_symbol_definition;
END_ENTITY;
(*
```

Attribute definitions:

definition: the **User_defined_symbol_definition** which defines this **User_defined_tile**.

2.19.10 User_defined_tiling

A **User_defined_tiling** is a type of **Fill_area_appearance** that is defined by an explicit listing of **Tiles**.

EXPRESS specification:

```
*)
ENTITY User_defined_tiling
SUBTYPE OF (Fill_area_appearance);
    angle          : DATA_TYPE;
    repeat_vector_1 : DATA_TYPE;
    repeat_vector_2 : DATA_TYPE;
    scale          : DATA_TYPE;
    definition      : Tile;
END_ENTITY;
(*
```

Attribute definitions:

:

angle: the rotation of the **Tile**, measured counter-clockwise, relative to the x-axis of the coordinate system in which the boundary of the **Fill_area** is defined.

NOTE – Because **Fill_area_appearance** attributes apply to all elements which constitute the contents of a **Fill_area**, the **angle** attribute of a **User_defined_tiling** should not be confused with the rotation attribute that is applied during the placement of other **Annotation_elements** and **Geometric_elements**. The **angle** attribute is applied universally to all elements of a given **User_defined_tiling** whereas the rotation is applied on an individual basis.

repeat_vector_1: the direction and the distance in that direction at which to place the **Tile** relative to the placement of a previous **Tile**.

repeat_vector_2: the second direction and the distance in that direction at which to place the **Tile** relative to the placement of a previous **Tile**.

scale: the ratio between the size of the **Tile** as defined and the size of the **Tile** as presented.

definition: the **Tile** which defines this **User_defined_tiling**.

2.20 Text Appearance

The Text Appearance group contains entities which define the appearance of text on a **Drawing**. Entities in the Text Appearance group are shown in Figure 21.

2.20.1 Text_appearance

A **Text_appearance** is a type of **Appearance** that governs the visual presentation of text.

EXPRESS specification:

```
*)
ENTITY Text_appearance
SUBTYPE OF (Appearance);
    character_aspect_ratio    : DATA_TYPE;
    character_rotation_angle  : DATA_TYPE;
    character_spacing         : DATA_TYPE;
    character_scale           : DATA_TYPE;
    character_slant_angle     : DATA_TYPE;
    color_definition          : Colour;
    font_definition           : Text_font;
END_ENTITY;
(*
```

Attribute definitions:

character_aspect_ratio: the ratio of the width of the character to the height of the character.

character_rotation_angle: the angular clockwise rotation of each character within the **Text_string** in which it appears. The point of rotation is the left-most point of each character at its baseline.

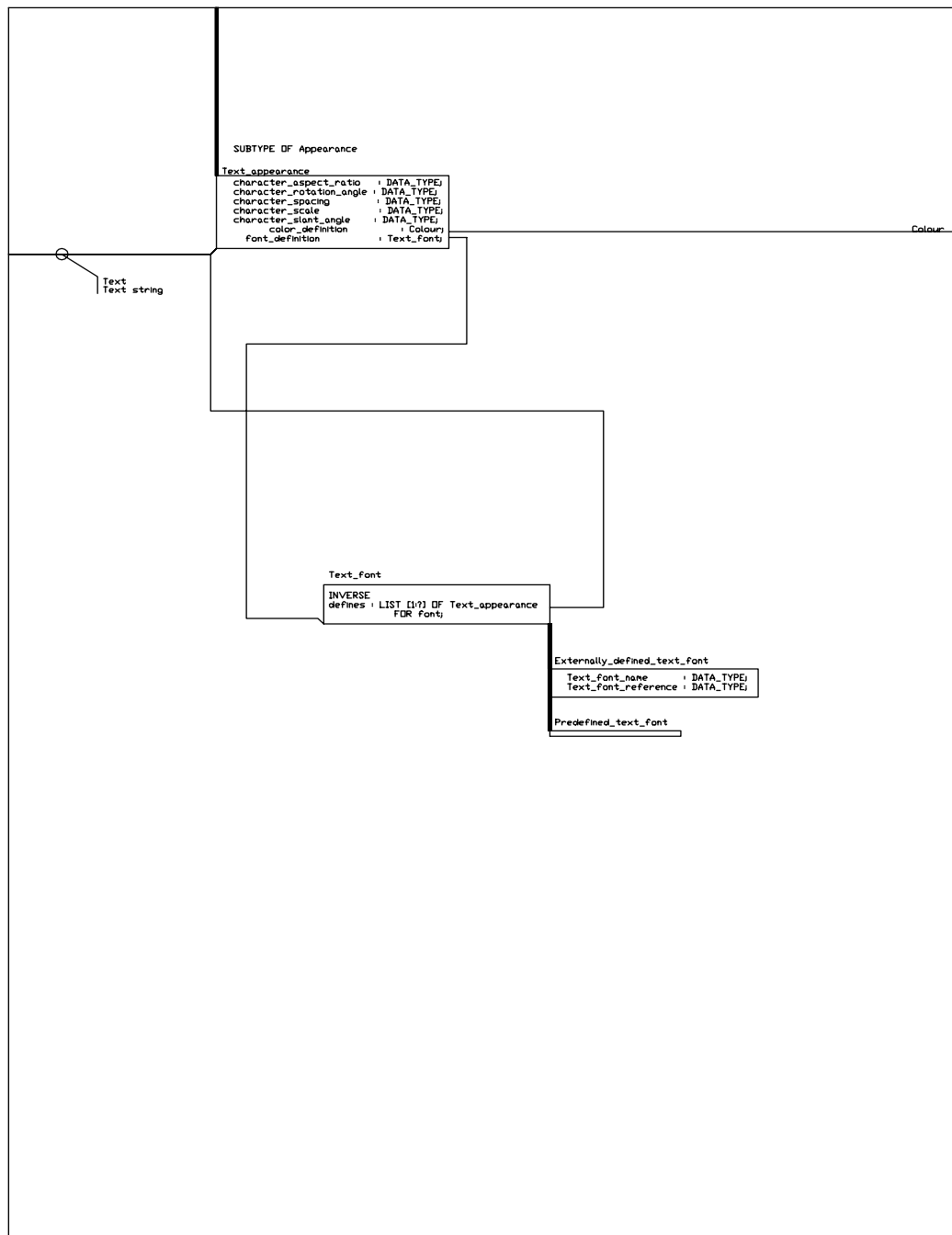


Figure 21 – Text Appearance

:

character_spacing: the distance between two adjacent characters. If the value of the **character_spacing** is zero, the characters are arranged one right after the other along the text path, without any additional space between. A positive value of **character_spacing** will insert additional space between characters. A negative value of **character_spacing** will cause adjacent characters to overlap.

character_slant_angle: the angular distance between the vertical axis of the individual character and an axis perpendicular to the baseline of the character, measured clockwise.

color_definition: the **Colour** which partially defines this **Text_appearance**.

font_definition: the **Text_font** which partially defines this **Text_appearance**.

character_scale: the ratio of the size of the text character as defined to the size of the text character as presented.

2.20.2 Externally_defined_text_font

An **Externally_defined_text_font** is a type of **Text_font** found in a known source that explicitly defines the text font. This known source is agreed to by all parties involved in the exchange of the **Drawings** on which the text font appears. An **Externally_defined_text_font** shall include the specification of the origin and physical form of the characters of the font.

EXPRESS specification:

```
*)
ENTITY Externally_defined_text_font
SUBTYPE OF ( Text_font);
    text_font_name      : DATA_TYPE;
    text_font_reference : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

text_font_name: the identification of a particular **Text_font** in the known source.

text_font_reference: the known source that contains a set of **Text_fonts** from which the **Text_font** is selected.

2.20.3 Predefined_text_font

A **Predefined_text_font** is a type of **Text_font** that is explicitly defined ISO 10303.

EXPRESS specification:

```
*)
ENTITY Predefined_text_font
SUBTYPE OF ( Text_font);
END_ENTITY;
(*
```

2.20.4 Text_font

A **Text_font** is the description of each individual character of a character set, including its form and spatial characteristics.

EXPRESS specification:

```
*)
ENTITY Text_font
SUPERTYPE OF (ONEOF (Externally_defined_text_font,
                     Predefined_text_font));

INVERSE
defines : LIST [1:?] OF Text_appearance
        FOR font;
END_ENTITY;
(*
```

Attribute definitions:

defines: the set of **Text_appearance** objects which this **Text_font** partially defines.

2.21 Appearance Element

The Appearance Element group contains those entities used in a variety of appearance environments. These entities are shown in Figure 22.

2.21.1 Colour

A **Colour** is a characteristic of the visual presentation of an element with respect to the light reflected by it.

EXPRESS specification:

```
*)
ENTITY Colour
SUPERTYPE OF ( ONEOF (Predefined_colour,
                     User_defined_colour));

END_ENTITY;
(*
```

2.21.2 Predefined_colour

A **Predefined_colour** is a type of **Colour** that has a specific visual appearance as defined in ISO 10303.

EXPRESS specification:

```
*)
ENTITY Predefined_colour
SUBTYPE OF (Colour);
END_ENTITY;
(*
```

:

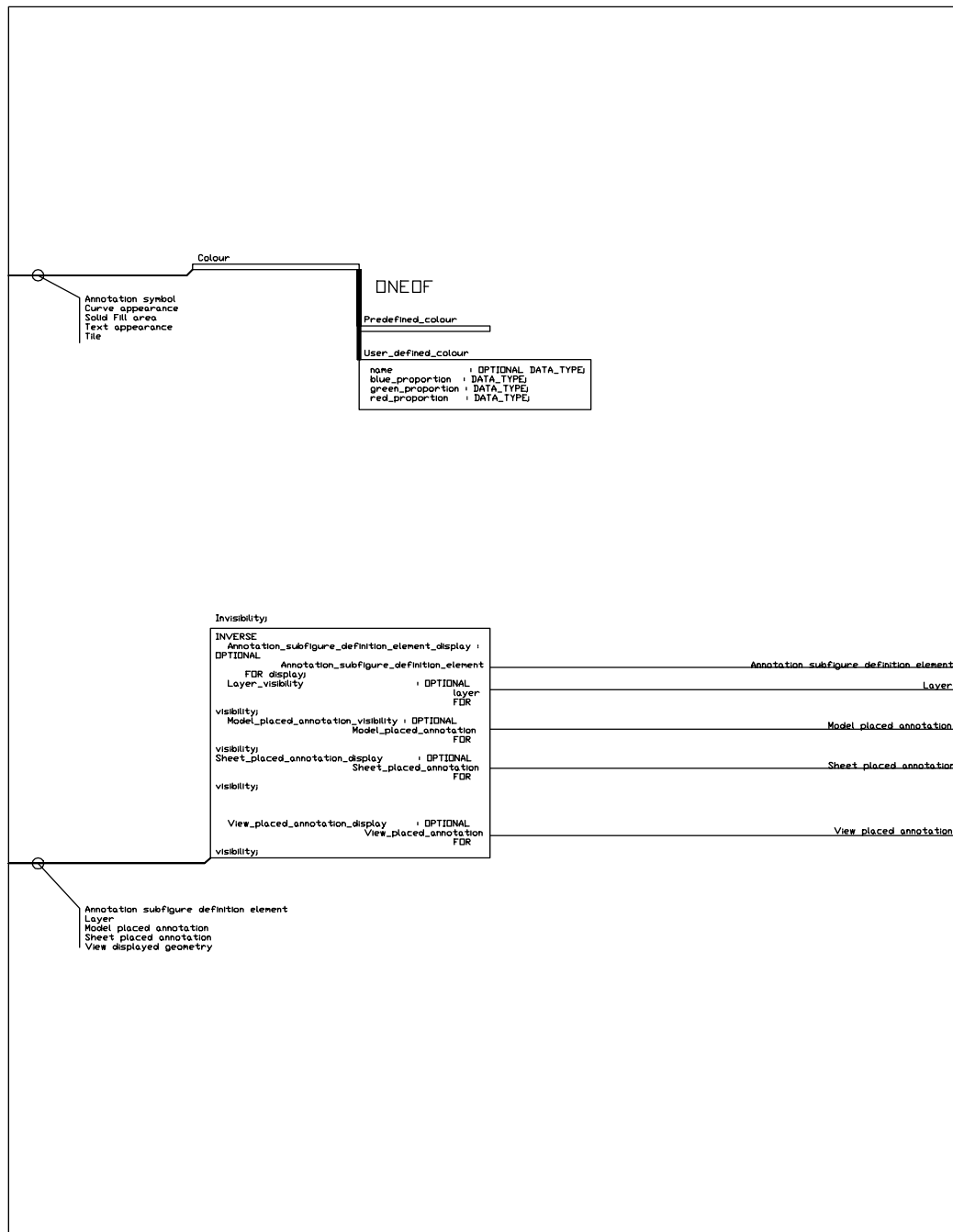


Figure 22 – Appearance Element

2.21.3 User_defined_colour

A **User_defined_colour** is a type of **Colour** that is defined by an explicit listing of the proportions of blue, green, and red.

EXPRESS specification:

```
*)
ENTITY User_defined_colour
SUBTYPE OF (Colour);
  name          : OPTIONAL DATA_TYPE;
  blue_proportion : DATA_TYPE;
  green_proportion : DATA_TYPE;
  red_proportion  : DATA_TYPE;
END_ENTITY;
(*
```

Attribute definitions:

name: the identification of a particular **User_defined_colour**.

blue_proportion: the level of intensity of the colour blue to be displayed.

NOTE – A value of 0 signifies that the colour blue is not displayed; a value of 255 signifies that the colour blue is displayed at full intensity.

green_proportion: the level of intensity of the colour green to be displayed.

NOTE – A value of 0 signifies that the colour green is not displayed; a value of 255 signifies that the colour green is displayed at full intensity.

red_proportion: the level of intensity of the colour red to be displayed.

NOTE – A value of 0 signifies that the colour red is not displayed; a value of 255 signifies that the colour red is displayed at full intensity.

2.21.4 Invisibility

An **Invisibility** is an indication that an individual element or collection of elements are not to be displayed in the visual presentation of the **Drawing**. **Invisibility** takes precedence over all other appearance characteristics assigned to the element.

EXAMPLES

17 – Within a **Draughting_shape_model** for a hotel room, all plumbing could be placed on a **Layer**. **Invisibility** related to this **Layer** would indicate the plumbing **Layer** is not to be displayed in the **Drawing**. By not presenting the **Layer**, the **Drawing** could show the architectural floor plan.

EXPRESS specification:

```
*)
ENTITY Invisibility;
```

:

```
INVERSE
  definition_display          : OPTIONAL
    Annotation_subfigure_definition_element
    FOR display;
  layer_visibility           : OPTIONAL Layer
    FOR visibility;
  model_placed_annotation_visibility : OPTIONAL
    Model_placed_annotation
    FOR visibility;
  sheet_placed_annotation_display : OPTIONAL
    Sheet_placed_annotation
    FOR visibility;
  view_placed_annotation_display : OPTIONAL View_placed_annotation
    FOR visibility;
END_ENTITY;
(*
```

Attribute definitions:

definition_display: an **Annotation_subfigure_definition_element** whose display may be governed by this **Invisibility**.

layer_visibility: the **Layer** whose visibility is governed by this **Invisibility** object.

sheet_placed_annotation_display: a **Sheet_placed_annotation** whose display is governed by this **Invisibility**.

model_placed_annotation_visibility: the **Model_placed_annotation** whose display is governed by this **Invisibility**.

view_placed_annotation_display: a **View_placed_annotation** whose display is governed by this **Invisibility**.

2.22 Grouping

The Grouping group contains entities defining the grouping of elements of a model. It includes Layer, as well as the group entities. Entities in the Grouping group are shown in Figure 23.

2.22.1 Group

A **Group** is a collection of elements and other previously defined **Groups** generated into related sets.

EXPRESS specification:

```
*)
ENTITY Group
SUPERTYPE OF (Sub_Group);
  name          : DATA_TYPE;
  description   : DATA_TYPE;
  contents      : LIST [1:?] OF Group_element;
```


:

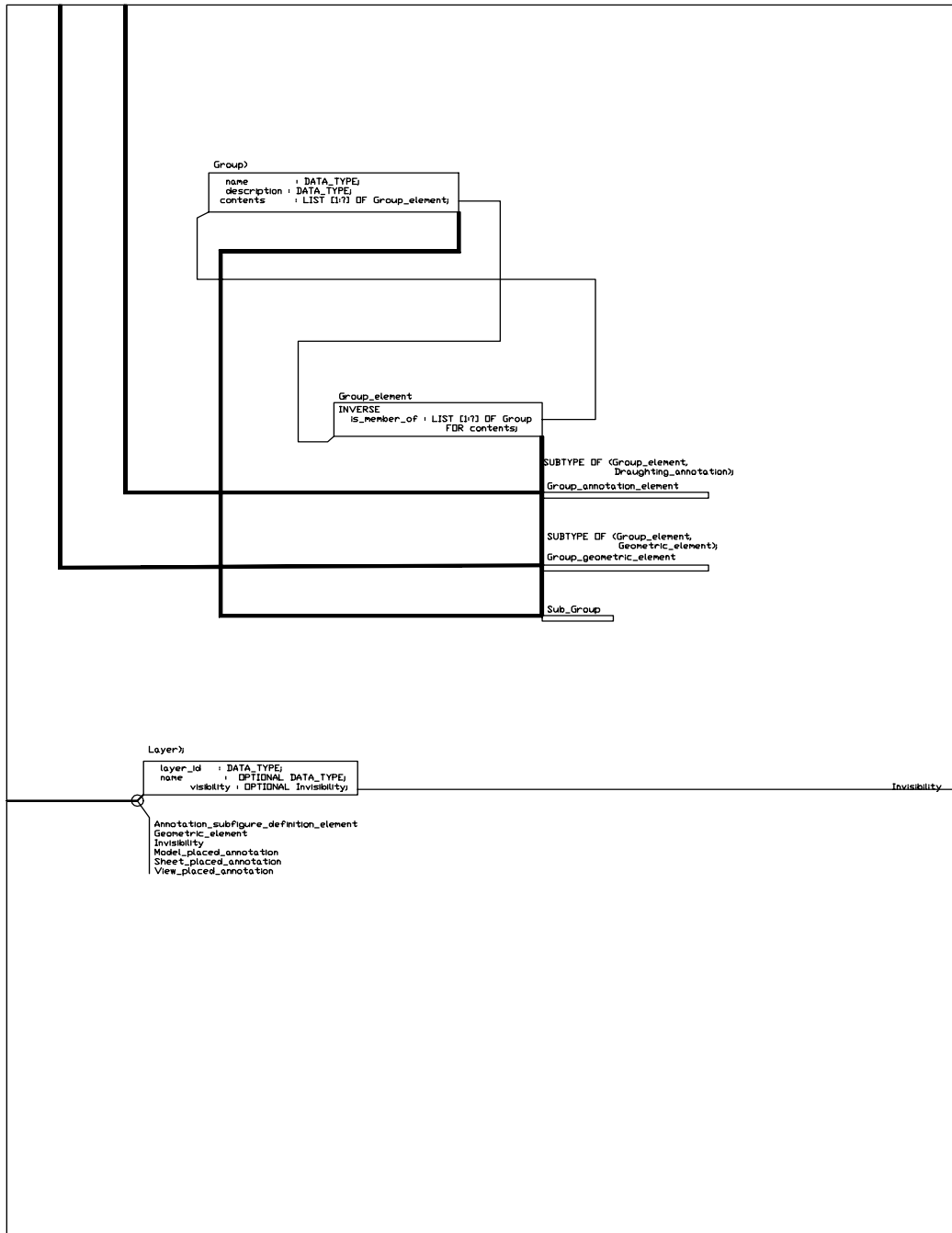


Figure 23 – Grouping

:

END_ENTITY;
(*

Attribute definitions:

name: the identification of a particular Group.

description: the content or subject matter of the Group.

contents: the set of **Group_element** objects which are contained within this **Group**.

2.22.2 Group_annotation_element

A **Group_annotation_element** is a type of **Group_element** that is annotation.

EXPRESS specification:

```
*)  
ENTITY Group_annotation_element  
SUBTYPE OF (Group_element,  
            Draughting_annotation);  
END_ENTITY;  
(*
```

2.22.3 Group_element

A **Group_element** is a member of a **Group**.

EXPRESS specification:

```
*)  
ENTITY Group_element  
SUPERTYPE OF (ONEOF (Group_annotation_element,  
                    Group_geometric_element,  
                    Sub_Group));  
  
INVERSE  
    is_member_of : LIST [1:?] OF Group  
                FOR contents;  
END_ENTITY;  
(*
```

Attribute definitions:

is_member_of: the set of **Group** objects of which this **Group_element** is a member.

2.22.4 Group_geometric_element

A **Group_geometric_element** is a type of **Group_element** that is a **Geometric_element**.

EXPRESS specification:

```
*)  
ENTITY Group_geometric_element  
SUBTYPE OF (Group_element,
```

:

```
Geometric_element);  
END_ENTITY;  
(*
```

2.22.5 Layer

A **Layer** is a collection of elements that is used to organize a **Drawing** and control the visibility of the elements. The association of specific application semantics to the assignment of elements of a Layer is outside the scope of ISO 10303.

EXAMPLES

18 – The use of a convention for naming of **Layers** to represent different aspects of a CAD model is an example of the association of specific application semantics.

EXPRESS specification:

```
*)  
ENTITY Layer;  
  layer_id    : DATA_TYPE;  
  name        : OPTIONAL DATA_TYPE;  
  visibility  : OPTIONAL Invisibility;  
END_ENTITY;  
(*
```

Attribute definitions:

layer_id: the identification of a particular **Layer**.

name: a description of the content or the usage of a particular **Layer**.

EXAMPLES

19 – The name could be dimensions, plumbing, or furniture.

visibility: a possible **Invisibility** which governs the display this **Layer**.

2.22.6 Sub_Group

A **Sub_Group** is a type of **Group_element** that is a collection of elements into a **Group** and is itself contained within another **Group**.

EXPRESS specification:

```
*)  
ENTITY Sub_Group  
SUBTYPE OF (Group,  
            Group_element);  
END_ENTITY;  
(*
```

EXPRESS specification:

:

*)

END_SCHEMA;

(*

3 The 202 ARM Objects

The following table shows each ARM object, its location, and those objects which either reference it or are subtypes of it.

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
2d cartesian coordinate space	Shape (2)	Annotation subfigure definition Drawing sheet Drawing sheet layout User defined symbol definition	
2d elementary geometric curve set	Shape (2)		
2d geometric curve set	Shape (2)		
2d wireframe with topology	Shape (2)		
3d cartesian coordinate space	Shape (2)		
3d non topological surface	Shape (2)		
3d non topological wireframe	Shape (2)		
3d wireframe with topology	Shape (2)		
Advanced b rep	Shape (2)		
Angle distance dimension	Associative Dimensions (12)		
Angular Dimension	Conventional Dimensions (11)	Dimension line	
Annotation curve	Annotation Curves (6)	Draughting callout Fill area boundary	Directed curve
Annotation element	Annotation (4)	Curve Distance dimension Distance dimension Geometric dimension Leader Projection line User defined symbol definition	Annotation curve Annotation subfigure Annotation symbol Fill area Text
Annotation subfigure	Annotation Subfigures (8)	Annotation subfigure definition	
Annotation subfigure definition	Annotation Subfigures (8)	2d cartesian coordinate space Annotation subfigure Annotation subfigure definition element	

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Annotation subfigure definition element	Annotation Subfigures (8)	Annotation subfigure definition Invisibility	
Annotation symbol	Annotation Symbols (7)	Dimension line Draughting callout Leader Structured dimension callout Annotation symbol	Externally defined symbol Predefined symbol User defined symbol
Appearance	Appearance (17)	Tile View displayed model annotation	Curve appearance Fill area appearance Text appearance
Approval	Product (1)	Drawing Drawing sheet	
Cartesian coordinate space	Shape (2)	Draughting shape model	2d cartesian coordinate space 3d cartesian coordinate space
Chained Dimension pair	Conventional Dimen- sions (11)		
Colour	Colour (21)	Annotation symbol Curve appearance Solid Fill area Text appearance Tile	Predefined colour User defined colour
Curve appearance	Curve Appearance (18)	Annotation curve Hatching pattern Line font View displayed geometry	Viewed surface appearance
Curve dimension	Conventional Dimen- sions (11)	Dimension line	
Curve Distance dimension	Associative Dimensions (12)		
Curve length size dimension	Associative Dimensions (12)		
Datum feature callout	Draughting Callouts (14)		
Datum target callout	Draughting Callouts (14)		
Diameter dimension	Conventional Dimen- sions (11)	Dimension line	
Diameter size dimension	Associative Dimensions (12)		

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Dimension	Conventional Dimensions (11)	Dimension callout Dimension sequence pair	Angular Dimension Curve dimension Diameter dimension Leader directed dimension Linear dimension Ordinate Dimension Radius dimension
Dimension callout	Draughting Callouts (14)	Dimension Geometric dimension	Structured dimension callout Unstructured dimension callout
Dimension line	Dimension Components (13)	Angular Dimension Annotation symbol Curve dimension Diameter dimension Linear dimension Radius dimension	
Dimension sequence pair	Conventional Dimensions (11)		Chained Dimension pair Parallel dimension pair
Dimension symbol	Draughting Annotation Symbols (15)		
Directed curve	Dimension Components (13)	Draughting callout	Dimension line Leader Projection line
Direction vector	Associative Dimensions (12)	Linear distance dimension	
Distance dimension	Associative Dimensions (12)		Angle distance dimension Curve Distance dimension Linear distance dimension

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Draughting annotation	Draughting Annotation (10)		Annotation element Annotation subfigure definition element Dimension Draughting callout Group annotation el- ement Model placed anno- tation Sheet placed annota- tion View placed annota- tion
Draughting callout	Draughting Callouts (14)	Annotation curve Annotation symbol Directed curve Structured dimension callout Text	Datum feature call- out Datum target callout Geometrical tolerance Unstructured dimen- sion callout
Draughting shape model	Shape (2)	Geometric element Model placed anno- tation Product definition Product version Sub model	2d elementary geometric curve set 2d geometric curve set 2d wireframe with topology 3d non topological surface 3d non topological wireframe 3d wireframe with topology Advanced b rep Elementary b rep Facetted b rep Manifold surface with topology Sub model definition
Drawing	Drawing Structure (3)	Approval Drawing sheet Product version	
Drawing sheet	Drawing Structure (3)	2d cartesian coordi- nate space Drawing Drawing view Sheet placed annota- tion	

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Drawing sheet layout	Drawing Structure (3)		
Drawing view	Drawing Structure (3)	2d cartesian coordinate space Drawing sheet Drawing view definition View placed annotation	
Drawing view definition	Drawing Structure (3)	Drawing view View displayed geometry View displayed model annotation	
Elementary b rep	Shape (2)		
Externally defined hatching	Fill Area Appearance (19)		
Externally defined line font	Curve Appearance (18)		
Externally defined symbol	Annotation Symbols (7)		
Externally defined text font	Text Appearance (20)		
Externally defined tile	Fill Area Appearance (19)		
Externally defined tiling	Fill Area Appearance (19)		
Faceted b rep	Shape (2)		
Fill area	Fill Areas (9)	Fill area appearance Fill area boundary	
Fill area appearance	Fill Area Appearance (19)	Fill area	Externally defined hatching Externally defined tiling Solid Fill area User defined hatching User defined tiling
Fill area boundary	Fill Areas (9)	Annotation curve Fill area	

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Geometric dimension	Associative Dimensions (12)	Tolerance	Distance dimension Size Dimension
Geometric element	Shape (2)	Curve Distance dimension Distance dimension Draughting shape model Fill area boundary Geometric dimension Leader Projection line View displayed geometry	Group geometric element
Geometrical tolerance	Draughting Callouts (14)		
Geometrical tolerance symbol	Draughting Annotation Symbols (15)		
Group	Grouping (22)	Group element	Sub Group
Group annotation element	Grouping (22)		
Group element	Grouping (22)	Group	Group annotation el- ement Group geometric ele- ment Sub Group
Group geometric element	Grouping (22)		
Hatching pattern	Fill Area Appearance (19)	User defined hatching	
Invisibility	Colour (21)	Annotation subfigure definition element Layer Model placed anno- tation Sheet placed annota- tion View displayed geometry	

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Layer	Grouping (22)	Annotation subfigure definition element Geometric element Invisibility Model placed anno- tation Sheet placed annota- tion View placed annota- tion	
Leader	Dimension Components (13)	Annotation symbol Leader directed dimension	
Leader directed dimension	Conventional Dimen- sions (11)	Leader	
Line font	Curve Appearance (18)	Curve appearance	Externally defined line font Predefined line font User defined line font
Linear dimension	Conventional Dimen- sions (11)	Dimension line	
Linear distance dimension	Associative Dimensions (12)	Direction vector	
Manifold surface with topology	Shape (2)		
Model placed annotation	Annotation Placement (16)	Draughting shape model Invisibility View displayed model annotation	
Ordinate Dimension	Conventional Dimen- sions (11)		
Organization	Product (1)	Approval Drawing Drawing sheet Product version	
Parallel dimension pair	Conventional Dimen- sions (11)		
Point marker symbol	Annotation Symbols (7)		
Predefined colour	Colour (21)		
Predefined line font	Curve Appearance (18)		

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Predefined symbol	Annotation Symbols (7)		Dimension symbol Geometrical tolerance symbol Point marker symbol Terminator symbol
Predefined text font	Text Appearance (20)		
Product definition	Product (1)	Product version	
Product version	Product (1)	Drawing Product definition	
Projection line	Dimension Components (13)	Angular Dimension Curve dimension Diameter dimension Linear dimension Ordinate Dimension Radius dimension	
Radius dimension	Conventional Dimen- sions (11)	Dimension line	
Radius size dimension	Associative Dimensions (12)		
Sheet placed annotation	Annotation Placement (16)	Drawing sheet Invisibility	
Size Dimension	Associative Dimensions (12)		Curve length size di- mension Diameter size dimen- sion Radius size dimension
Solid Fill area	Fill Area Appearance (19)		
Structured dimension callout	Draughting Callouts (14)	Annotation symbol Draughting callout Text string	
Sub group	Grouping (22)		
Sub model	Shape (2)	Draughting shape model Sub model definition	
Sub model definition	Shape (2)	Sub model	
Terminator symbol	Draughting Annotation Symbols (15)		
Text	Text (5)	Draughting callout Text string	
Text appearance	Text Appearance (20)	Text Text font Text string	

:

OBJECT NAME	MODULE (LOCATION)	REFERENCE	SUBTYPE
Text font	Text Appearance (20)	Text appearance	Externally defined text font Predefined text font
Text string	Text (5)	Structured dimension callout Text	
Tile	Fill Area Appearance (19)	User defined tiling	Externally defined tile User defined tile
Tolerance	Associative Dimensions (12)	Geometric dimension	
Unstructured dimension callout	Draughting Callouts (14)		
User defined colour	Colour (21)		
User defined hatching	Fill Area Appearance (19)	Hatching pattern	
User defined line font	Curve Appearance (18)		
User defined symbol	Annotation Symbols (7)		
User defined symbol definition	Annotation Symbols (7)	2d cartesian coordinate space Annotation element User defined symbol User defined tile	Drawing sheet layout
User defined tile	Fill Area Appearance (19)		
User defined tiling	Fill Area Appearance (19)	Tile	
View displayed geometry	Drawing Structure (3)	Drawing view definition	
View displayed model annotation	Drawing Structure (3)	Drawing view definition	
View placed annotation	Annotation Placement (16)	Drawing view Invisibility	
Viewed surface appearance	Curve Appearance (18)		